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ECONOMIC GEOGRAPHY

JANUARY

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Preston E. James

THE FLORIDA CITRUS CROP
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BORDERLAND OF THE WISCONSIN DRIFTLESS AREA
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SITE OF EARLY LOS ANGELES
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THE PORTALES REGION, THE LLANO ESTACADO
Alfred W. Booth

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BRAZIL

JUST as our country is the greatest state of the earth's temperate lands, so is Brazil the greatest state of tropical regions—greatest in extent, greatest in resources, greatest in potentialities of economic strength and political power. By almost any measure is she among the world's greatest of the future, when her frontiers of population and industrial development shall have been pushed back to the mountain ramparts of her Andean boundaries.

A tropical empire in the making, Brazil is but now gauging her own possibilities of progress and political expansion, appraising her own basic advantages and fundamental problems, in the light of an impending new world order, and under the conditions of the new system of international relationships upon which her future will be built.

Brazil and the United States have much to help each other. There can be little conflict between their deepest interests, little cause for controversy over their material or cultural associations in any field of activity. From every point of view they should be allies always, in peace and in war.

ECONOMIC GEOGRAPHY

VOL. 18 JANUARY, 1942 No. 1

IPSWICH, ENGLAND

Chauncy D. Harris

IPSWICH, a town of 90,000 population, is located 69 miles northeast of London at the head of navigation on the River Orwell, an estuary which extends 12 miles southeast to the North Sea (Figure 1). The non-tidal portion of the river above the town is called the Gipping, from which the town is said to have taken its ancient name Gipeswic, or Gipping Bay (Figure 2).

That the estuary is defensible and the most easily navigated of the inlets along the Suffolk Coast has been an important factor in the rise of Ipswich. Although the county town and the commercial and industrial center of Suffolk, Ipswich is not one of the few British urban units traditionally called a *city*. The town is not on any of the British coalfields and it arose primarily as a commercial center, yet today manufacturing overshadows trade in the employment structure; 45 per cent of all employed persons are engaged in manufacturing compared to 22 per cent in trade. Many of the industries share in the large export trade of British manufactured products.

CHANGING FUNCTIONS

Ipswich has passed through several critical periods in its functions and geographic relationships; the most important position factors of the town have been, in turn, location near the continent, location in an area of arable agriculture, and location near London (Figure 1). The town dates back to settlement by the Angles and was an important center of population as early as Domesday times. During the wool-exporting period up to the 14th century, the prosperity of the town depended on its coastal position opposite markets in the textile towns of Flanders. Later wool exports declined with the development of the English woolen industry; coastal position then facilitated the entry of Flemish, Dutch, Walloon, and French Huguenot immigrants who made a significant contribution to the rise of textile industries in Ipswich and its hinterland. In 1470 Suffolk ranked first among the textile counties of England; the East Anglian industrial area, of which Suffolk was part, produced about a quarter of the woolens and most of the worsteds in England. With the 18th century decline of woolen manufacturing in East Anglia, Ipswich became chiefly a port for the shipment of wheat and barley from adjacent parts of the arable fringe of eastern England. Ips-

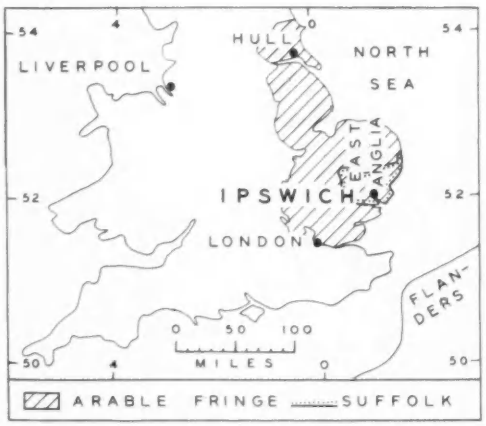

FIGURE 1.—Location of Ipswich. This town is near London, near the Continent, and within the arable fringe which includes the counties in eastern England that have more plowed land than permanent pasture.

wich also became a center in the manufacture of agricultural implements, milling equipment, and fertilizers for this agricultural hinterland. Such manufacturing persisted even after the decline of local wheat production due to the rise of non-European wheat belts in the late 19th century. In recent decades the town has benefited from position near London, for new industries have come to Ipswich chiefly as an industrial satellite of that great city. The development is part of the so-called southward migration of industry, which in reality is not so much a migration as the rise of new light industries near the marketing center of London rather than in the coalfield industrial areas.

The World War of 1914–1918 left its mark. It stopped the flow of agricultural machinery from Ipswich to Russia and of hemp from Russia to Ipswich. Changed styles ruined the once important corset trade. Wartime needs expanded engineering factories and occasioned the taking of a now-closed motor factory from a parent German company. In the wake of the war came increased nationalism and the decline of exports of agricultural machinery, furniture, leather goods, and miscellaneous machinery. On the other hand, the clothing factories have benefited from tariffs on artificial silk underwear; an American branch factory for heating and plumbing equipment has been established within British tariff walls; a sugar factory has been made possible by a direct government subsidy; and the farming hinterland has increased wheat and barley production.

Ipswich is again in a critical period. Position near the Continent makes towns in southeastern England vulnerable to air attack; the present war may therefore encourage a northward migration of industry away from such towns. Another danger is a threatened post-war loss of markets for exported industrial products: there may be a general decline in world trade, a loss in the British share of that trade, or a rise of industries in countries now importing manufactured goods. During the last decade, however, most of the exports have gone to other parts of the British Empire, and these markets are relatively secure. The factories may be forced to shift to new products; the large agricultural machinery factory compensated for an earlier decline in export trade by manufacturing a variety of products for the British market.

LAYOUT

Ipswich is nestled in the valley of the River Orwell and on the adjacent slopes of rolling morainal hills. An observer facing east on Stoke Bridge (B in Figure 2), the lowest bridging point on the Orwell, looks at the port of Ipswich, stretching first east then south. Upstream to the west and northwest lie the low, poorly drained lands along the river. This area near the port, the river, and the railroad is largely industrial, and it includes most of the industries of Ipswich (Figures 4, 5 and 6).

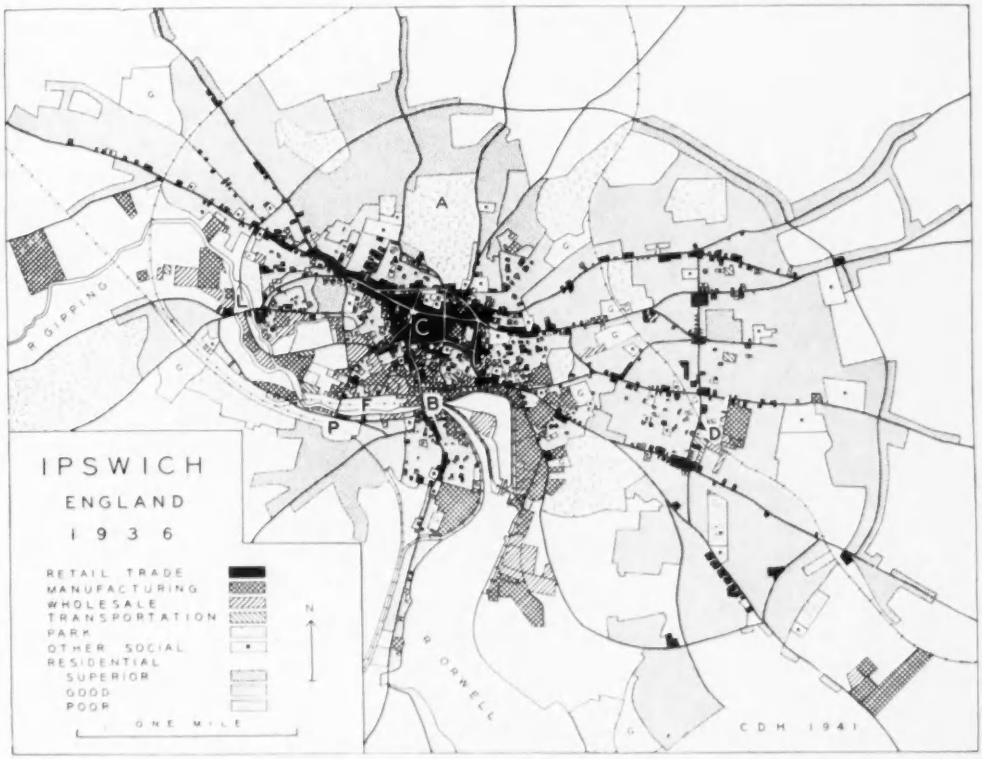

FIGURE 2.—Land utilization in Ipswich. The center of town is a small square called Cornhill (C), to which bridge roads come from the south over Stoke Bridge (B), from the railway passenger station (P) past the freight yards (F), and from London Bridge (L) on the west. North of Cornhill is the large Christ Church Park (A). Allotment gardens are indicated by the letter G.

Two small industrial areas, however, lie along a railroad in the eastern part of the town, and some factories are in the Central Business District.

Half a mile north of Stoke Bridge is the town center, Cornhill, from which the Central Business District extends half a mile east and about a quarter-mile in the other directions. This district includes most of the retail shops, government buildings, and churches of Ipswich. Between the Central Business District and the river on the south and southwest is an area of mixed retail trade, wholesale trade, manufacturing, and low-grade housing.

North of the central area the land rises sharply to hills 150 feet above the port. Christ Church Park occupies much of the slope. The rise to the east is much more gradual and that to the west is scarcely perceptible.

The town is tied together by a radial street pattern, whose origins go back more than a thousand years to the Anglo-Saxon period. In spite of continuous gentle curves, the narrow streets offer direct routes from Cornhill to most parts of the town. Fortunately for the traffic problem, most people use either buses or bicycles, both of which are more efficient than private passenger cars in the use of road space. Swarms of bicycles cover the streets as the factories close at noon and at 5.00 o'clock in the evening. Through-car traffic is routed over the new by-pass which circles most of the outer town north of the river. The curved roads on the site of the old city wall immediately north of Cornhill

provide important traffic and parking relief in the central area.

OUTWARD MOVEMENT OF RESIDENCES AND INDUSTRY

During the last century and a half there has been a notable expansion in the area occupied by Ipswich. The built-up area of Ipswich now covers 6.9 square miles and the average density of population in the built-up area is 13,000 per square mile, much higher than in most American cities. Less than a century ago (1851) the built-up area was only one square mile and the density 33,000. The important expansion, however, dates from about the beginning of the 19th century when the old town gates were torn down; the town wall had enclosed a central area of 0.15 square miles which had been built up since medieval times.

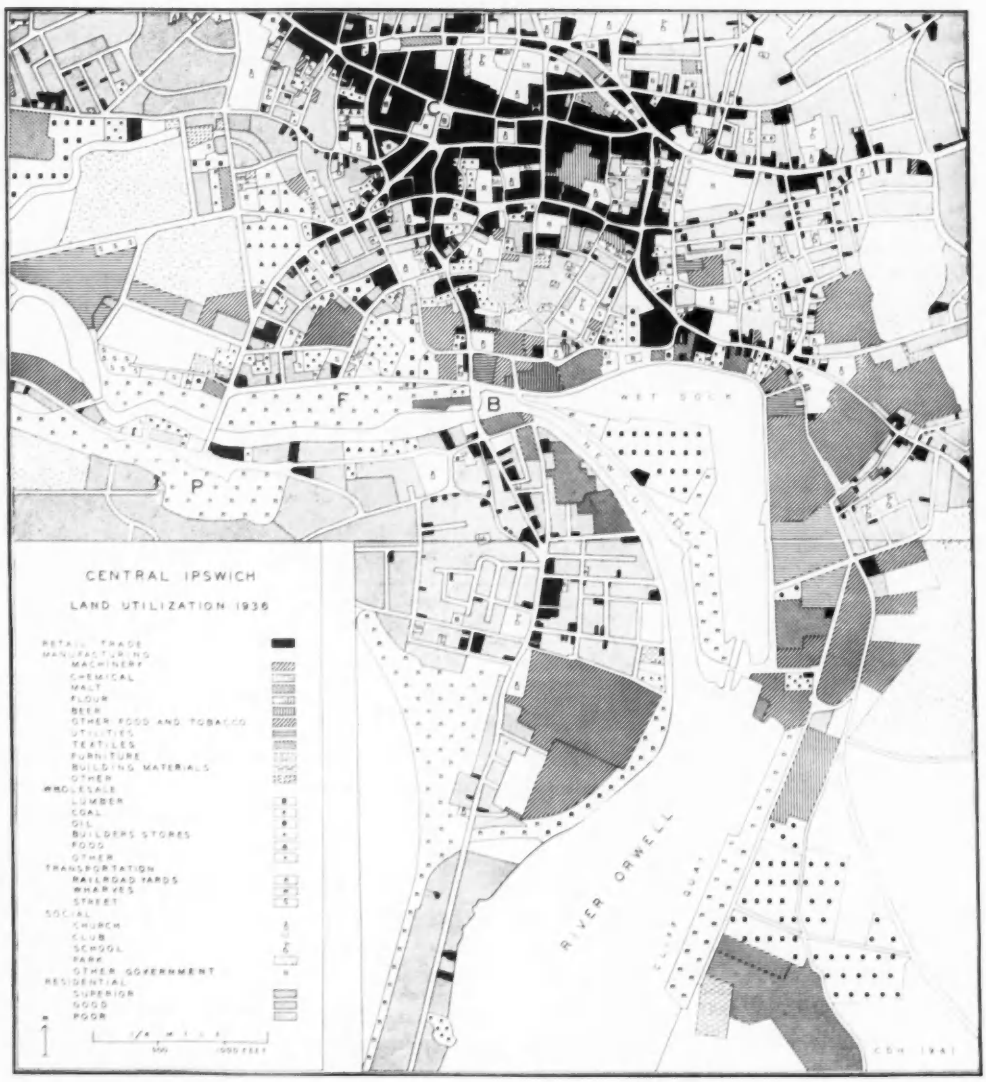

FIGURE 3.—Central Ipswich. The two most important places in the Central Business District are Cornhill (C) and Great White Horse Corner (H). Significant points in the industrial area are the railway passenger station (P), freight station (F), and Stoke Bridge (B).

A housing boom during the 1920's and 1930's greatly enlarged the built-up area. This boom was related to the increased number of families, to improved transportation, and to the need for modernization. In Ipswich in 1931 there were 22,486 dwellings, of which nearly a quarter had been built in the previous ten years. During the intercensal years 1921 to 1931 the 23 per cent increase in the number of houses corresponded closely to the increase in the number of families. That the per cent increase in families was 20 per cent whereas the increase in population was only 10 per cent is due to a decrease in size of the average Ipswich family from 4.05 to 3.68. Improved transportation encouraged new building on the edge of town; the ordinary worker can now live away from the crowded center. The need for modernization in poor areas led to direct government rehousing. As part of a comprehensive slum clearance program, the municipality built 1,849 new houses in the decade 1921–1931 and 3,072 were erected by private enterprise. A former slum on the western edge of the Central Business District has been demolished and rebuilt in houses of good quality (Figure 3). A large group of town-built, semi-detached houses forms the southernmost residential area east of the Orwell in Figure 2. The location of this project, which is chiefly for industrial workers, has been planned in connection with a zoned industrial area about a mile farther east.

The rise of the port, the failure of the railway to penetrate the central area, and the small size of available sites in built-up areas have encouraged an outward movement of expanding or heavy industries. The agricultural machinery factory and the gas works early moved from the present commercial core to the port. Divided and scattered fertilizer plants were recently replaced by a single large factory at the southern edge of the port. Even the cattle market has experienced a similar centrifugal movement. A manufacturer of milling equipment with two separated factories in the central area finally built an additional large plant in the eastern part of town where there is room for expansion and a rail connection. Division due to the limited size of available spaces finds expression in nine different yards of a lumber merchant and eight different units of a malting and grain company.

FIGURE 4.—Looking northeast from Stoke Bridge. From left to right are an oil mill and a manufacturing confectioner on the New Cut and a flour mill and associated grain elevator facing on the Wet Dock (cf. Figure 3). The sailing barges in the foreground are typical of the port of Ipswich; these have brought oil seeds from London. (Courtesy of the Ipswich Industrial Development Association.)

RETAIL TRADE

Cornhill is the governmental, financial, and retail heart of Ipswich. On this small square are located the town hall, central post office, and the grain market; in the immediate vicinity are the offices of the county court, the leading department store, the four chief hotels, insurance offices, and the five leading banks—all branches of the five principal national chain banks.

The core of high-class retail trade lies along the street which joins Cornhill and Great White Horse Corner, the busiest corner in town (Figure 7).

This street within a short distance is called Westgate, Tavern, and Carr Streets; it contains many tailors, high-class clothing shops, variety stores, department stores, and specialty shops with prominent window displays and pleasing store fronts.

The remaining parts of the Central Business District contain: (1) stores requiring large storage space for hardware, furniture, and automobiles; (2) stores dealing in cheaper grades of work clothing, in second-hand goods, and in pawn-shop goods; (3) stores selling groceries, fruits and vegetables, meat, fish, poultry, game, and other foodstuffs.

Most of the churches are located on the periphery of the Central Business District. The variety of churches is typical of the English-speaking world. Most numerous are churches of the Established Church of England, but there are several each for Baptists, Congregationalists, Methodists, and Roman Catholics, and one each for Presbyterians, Unitarians, and Christian Scientists. On the northern edge of the district are the town museum with good archeological and geological exhibits, and the public library, which dates back more than three centuries. On the eastern edge are the County Hall and the prison, which occupies the largest government area in Figure 3.

Varied neighborhood retail units extend throughout town, except for the high-class residential areas, the circular by-pass highway restricted by zoning, and the industrial port section, which has only "pubs." In other parts of town there are many grocery, butcher, fish and chip, and bicycle shops, public houses, shoe repairers, hairdressers, and confectionery shops (frequently selling also tobacco and newspapers).

Neighborhood retail patterns include linear, clustered, and dispersed types. In both the eastern and western sections, shops are strongly aligned along highways leading to the center of town. In the newly built and zoned southeastern section, retail trade has been restricted to planned clusters. In the older sections, small shops are widely dispersed, as may be noted in the poor residential areas immediately south of the Orwell and immediately east of the Central Business District (Figure 3).

RAILWAYS AND PORT

The London and North Eastern Railway from London enters the southwestern part of Ipswich. After passing through a short tunnel, it reaches the passenger station and then continues northwest toward Norwich (Figure 2). The East Suffolk line to Yarmouth leaves the above line in the western part of town and curves northeast. A branch of this line curves south to serve the eastern part of town with a number of industries and a minor freight station at Derby Road (D in Figure 2). Just west of the main passenger station, a line crosses the river to the main freight yard north of the river. From this line one spur track serves the north and east sides of the docks and another the medial wharf between the Wet Dock and the New Cut. A spur from the south serves the west side of the docks.

Since the railway does not penetrate the Central Business District, many of the smaller manufacturers and wholesalers lack rail connections and are dependent either on trucks or on horse-drawn wagons. The largest hauling companies are near the freight yards and the port, but several dozen small haulage contractors are scattered through the town.

Water transportation is of major importance. The Wet Dock was constructed in 1841 by making an L-shaped portion of the Orwell a dock and by re-routing the river through the New

Cut, an artificial channel on the west (Figures 3 and 6). Water in the Wet Dock is kept at a constant level; ships pass through a lock between dock and river. Some of the privately owned quays on the north and east are only a few feet deep but the public quays on the south and west provide a water depth of 23 feet. Cliff Quay, completed in 1929, faces directly on the Orwell; the water level varies 13′ 6″ at spring tides and 9′ at neap tides. With a depth of 28 feet at low water, it can accommodate the largest ships that can come up the dredged channel of the Orwell (19 feet at low water). Butterman's Bay, six miles downstream, is an outport for unloading grain from large vessels into barges. Ocean-going vessels up to 4,000 tons can unload at Butterman's Bay, Cliff Quay, or the Wet Dock, but coastal barges carry much of the trade, especially imported goods reshipped to Ipswich from London.

FIGURE 5.—Looking northwest in the western end of the Wet Dock. From right to left are a malthouse, feed-grain elevator, flour mill, and associated grain elevator.

The goods coming into the port of Ipswich are chiefly of five types: grain, oil seeds, fertilizers, iron, and general supplies (Table I). The first three are closely related to the agriculture of the hinterland. Grain imports include wheat for flour, barley for malt, and maize and meal for livestock feed. Another livestock feed, oil cake, is both imported and manufactured from cottonseed and linseed in Ipswich. Intensive local production of crops is reflected in the import of fertilizers and of raw materials such as phosphates, nitrates, ammonia, and potash. Coastwise shipments of pig and bar iron terminate at the machinery factories. General supplies such as coastwise coal and stone, and imported petroleum and lumber bulk large in the incoming tonnage statistics of Ipswich as of many ports.

Shipments from the port are largely coastwise: maize, wheat, and barley reshipments; flour, malt, vegetable oil, fertilizers, and burnt ore made from imported materials; machinery from the engineering works; sugar from the sugar factory; and scrap iron. The total of all shipments from Ipswich, however, barely equals the receipts of either maize or wheat.

A bi-weekly coastal steamer service connects Ipswich with Edinburgh, Glasgow, and intermediate points. The Ipswich terminal lies on the north bank of the Wet Dock, immediately west of

the Old Custom House, headquarters for the Ipswich Dock Commission (Figure 3). During the summer a daily steamboat joins Ipswich with Harwich, the continental ferry-town at the mouth of the Orwell, and with Felixstone, a resort town a few miles north.

A significant change took place in the port section early in the nineteenth century. Previously town notables had maintained river-side mansions with beautiful water gardens, but with the coming of heavy industries, and of trade in such products as coal, the river was no longer a desirable residential area, and many of the old mansions were converted into taverns for sailors.

TABLE I

TRADE OF THE PORT OF IPSWICH, 1934–1935*

IMPORTS	*Tons*	EXPORTS	*Tons*
Grains		Flour	20,319
maize	83,111	Maize	18,906
wheat	77,223	Wheat	1,898
barley	29,221	Barley	1,357
meal, etc.	20,592	Malt	2,020
		Vegetable oil	3,455
Oil seeds and cake		Sugar	3,186
cottonseed	6,908	Superphosphate	5,055
linseed	6,943	Burnt ore	11,858
oil cake	5,934	Machinery	1,657
		Scrap iron	3,229
Fertilizers			
phosphates	42,021		
pyrite	17,280		
other	20,297		
Iron, pig and bar	6,372		
General			
coal	200,277		
petroleum	78,658		
stone	69,001		
wood	*ca.* 40,000		

*From Ipswich Dock Commission: Port of Ipswich, Year ended March 25, 1935. Recent figures have been suppressed for the duration of the present war.

WHOLESALE TRADE

The wholesale trade of Ipswich arises from the function of the town as a port and as the commercial center for Suffolk. Most of the goods wholesaled in Ipswich are bulky. Gasoline is unloaded at Cliff Quay for distribution to town and hinterland. Coal comes by coastwise shipping and by rail for distribution chiefly to the town itself. Most of the sea-borne coal is unloaded at the public quay on the west side of the Wet Dock. Other coal yards are located near the main freight yard and at Derby Road Station. Lumber is unloaded at Cliff Quay and on the south side of the Wet Dock for distribution to town and hinterland and for use in a number of lumber mills located on the southern and western edges of the Central Business District (Figure 3). Partly because of the fire hazard, but chiefly because of limited size of available spaces, the lumberyards are scattered. In addition to the above, a wide variety of small wholesalers are located between the Central Business District and the port.

Ipswich has two livestock markets and an auction for poultry and small animal products. These lie just southwest of the Central Business District (wholesale food in Figure 3). On Tuesday this part of town is crowded with livestock men selling fat livestock for slaughter or buying lean animals for fattening. There is no large packing plant. Animals are slaughtered and dressed by small slaughter houses, usually associated with retail butcher shops.

MANUFACTURING

Manufacturing in Ipswich employed 15,920 persons at the time of the last census (1931). Industries either directly or indirectly related to the agricultural hinterland employed about 4,000, miscellaneous industries with a national market employed about 5,500, and industries of local importance employed the remaining 6,420.

Agriculturally-related Industries.—This group includes the making of farm implements and related products, milling equipment, sacks and haystack covers, fertilizers, livestock feeds, flour, malt, and sugar.

The making of agricultural machinery, the most significant single industry in Ipswich, employs 2,000 people. The firm of Ransomes, Sims, and Jefferies stems directly from Robert Ransome, who began the manufacture of agricultural implements at Ipswich in 1789. The industry is related to the location of Ipswich in the arable eastern fringe, which produces most of the English wheat and barley and constitutes the chief English market for plows and other types of farm implements. Location of the industry in a port city made possible the receipt of pig iron and coal by coastwise shipping. For a century after its founding, the factory manufactured chiefly for the nearby English market, but with the decline of English wheat production, new markets were found in the competing overseas wheat belts; at one time two-thirds of the total production was exported. The factory has expanded to fill twelve blocks of machinery works shown on the east side of the Wet Dock in Figure 3.

On the west side of the Orwell below the New Cut is another descendant from the early farm implement business; it is now a general engineering company employing 700 in making railway equipment and other products (Ransomes and Rapier). Many products are chiefly exported; control gates, for example, have been supplied to large irrigation dams in India and Egypt. The impact of large-scale American methods is evidenced in the manufacture of American-designed excavators and concrete mixers for the British market.

The factory making mill equipment at first served chiefly the adjacent grain-producing district, but it now produces for the whole British market. The 480 people employed are scattered among three different plants, two on crowded land near Stoke Bridge and one near Derby Road Station.

FIGURE 6.—Looking northwest up the New Cut. On the west side of the Orwell are an impressive array of malthouses. In the distance are the feed-grain elevator, flour mill, and associated elevator.

Two textile industries serve farm needs. The larger employs 400 in making chiefly jute bags for handling grain and other commodities; its origins go back to the old textile industries of Ipswich. The smaller one makes haystack covers, bags, and tents.

The fertilizer industry reflects both the agricultural hinterland and the previous utilization of a local raw material. In the middle of the 19th century low-grade local phosphate deposits were utilized, but phosphates are now brought from Algeria and Florida to a large factory located on and near Cliff Quay; the Dock Commission would not permit

the sulphuric acid section of the factory to be on the quay itself. Part of the manufactured superphosphate is mixed locally with other fertilizer materials, part is sent coastwise to other mixing plants in the United Kingdom, and part is exported to the Dominions.

The oil mill is located just below Stoke Bridge (Figure 4). Sailing barges bring cottonseed and linseed from London; the former is originally from Egypt or the Sudan, the latter from Argentina. The linseed and cottonseed are returned to London, but the bulky oil cake is distributed as cattle feed throughout East Anglia.

On the north side of the Wet Dock is a large elevator at which maize and other livestock feeds are unloaded by barges from London or by boats from Argentina (Figure 5). The maize is loaded into hundred-weight bags and is hauled by a score of horse-drawn wagons for about a mile to the east side of the Wet Dock, where a mill makes patented livestock feeds. Both elevator and mill are associated with malthouses and are shown under malt manufacturers in Figure 3.

Flour mills once processed chiefly local wheat. Nowadays barges from London or Butterman's Bay bring imported wheat to the large flour mill located on the north side of the Wet Dock (Figure 5). The flour is distributed through East Anglia by truck. There are also three smaller flour mills, one of which specializes in flour made from local soft wheat.

Malthouses are among the most striking buildings in the port section of Ipswich and properly so, for Ipswich is one of the leading British centers in malt production. The industry was once dispersed through the barley-producing lands of East Anglia, but with increasing use of imported barley, the industry has become localized in the port. Four large malthouses line the west bank of the New Cut; others are found on the north and east side of the Wet Dock and near the Orwell upstream (Figures 5 and 6).

The Ipswich sugar factory located on the River Gipping (extreme west of Figure 2) is one of the 17 English factories which were built after the World War of 1914–1918. The shortage of sugar during that war led the government to establish a large subsidy for sugar produced from home-grown sugar beets. The Ipswich hinterland as part of the relatively small area of English arable agriculture benefited from this subsidy.

General Industries with a National Market.—Another group of industries in Ipswich are not rooted in the rural hinterland, but are located in the town as one of the lesser industrial towns of Britain, particularly as a manufacturing satellite of London. The tributary area for these industries is chiefly the United Kingdom, though there are some exports.

Three engineering concerns, which together employ 1,500, are not indigenous to Ipswich but represent migrations. A company making air compressors migrated from Birmingham; one making brass and bronze alloys for the Admiralty came from London, and Crane, Ltd., makers of plumbing and heating equipment, established a branch factory from the United States. All wished to be near but not in London; Ipswich was merely one of the towns offering cheap land, low taxes, and cheap labor (partly unemployed farm laborers). Because of large space requirements, the factories are located on the outer edge of the built-up area, two on the west and one on the southeast (Figure 2).

The function of Ipswich as an industrial satellite of London is further illustrated in the clothing industry,

which employs 2,400. Two branches of London factories perform specialized processes on goods brought from and returned to London by truck. The other two are Ipswich firms but both market almost wholly through London. The advantages of Ipswich are largely those of cheap female labor from families whose men work in the engineering industries. Since the factories use little space but employ many people, they are located near the Central Business District (Figure 3). The two indigenous factories have been located for about a century on the site of the former city wall just north of Cornhill.

Although of local origin, a number of industries making consumer's goods have developed national markets. A small tobacco shop founded in 1790 has grown into a factory now employing 500 women. A large manufacturing confectionery has similarly grown from a local concern founded in 1824. A leather tanning and currying factory dates from 1716. These, together with a dozen other factories dating back at least a century, serve as reminders of the maturity of industrial life in England; localization of such industries in Ipswich is to be explained largely on the basis of historical factors or of the chance location of able management.

Among the other Ipswich factories with a national market are three making furniture, and one each making leather goods, shoes, industrial alcohol, and yeast.

Industries of Local Importance.—More than 6,000 people are employed in industries of local importance, such as building construction, electricity and gas plants, and breweries. Building and decorating alone employ about 2,000; scattered builders' stores are shown in Figure 3. Service industries for building include factories making bricks and structural steel. The town-owned electric power station, although located on the river, receives coal by rail from the docks; it supplies increasing amounts of power to industries. The large gas works also supply industrial power. They were located on the east side of the Wet Dock for the receipt of seaborne coal. Two centuries ago a brewery was located at Holy Wells east of Cliff Quay in order to get water of proper hardness. Capital accumulated by this company was formerly used for ship-building in Ipswich, for commerce on the high seas, and for taverns to accommodate sailors. Another brewery lies within the eastern part of the Central Business District.

Residential Areas

The growth of the town has been broadly symmetrical, although residential areas extend for a distance of 2½ miles from Cornhill on east and southeast and 2 miles northwest, but only one mile in large sections of the north, west, and south. Christ Church Park and the hills have restricted building on the north. Industrial areas and the river have formed a barrier on the west and south, though in each case small residential areas have arisen beyond the barriers.

Quality of housing increases with altitude and with distance from the crowded slums in the central part of town. The best residential areas are in the high north, good areas in the intermediate east, and poor areas in the center and low west. The worst slums lie between the brewery and the prison on the eastern edge of the Central Business District (Figure 3). Here crowded tenements nearly surround narrow grassless courts. In the central area one sees chiefly, however, continuous rows of red brick houses facing directly on the street. It is the dreary housing typical of the period of industrial expansion

FIGURE 7.—View east along Tavern Street at White Horse Corner in the commercial core. Note the double-deck bus, the overhead lines for the trolley bus, and the small car. The five shops on the right side of the picture are, according to their own terms, jewellers, costumiers, umbrella makers, blouse specialists, and drapers (who sell dry goods). (Courtesy of the Ipswich Industrial Development Association.)

about the beginning of the 19th century. Regularly spaced chimney pots silhouetted against the sky are evidence that most of the heating is done by small coal-burning fireplaces. Most of the houses of the central area are of poor quality and most such houses are in the central area, although one section of poor housing extends to the northwestern edge of town. The extensive residential section of good quality in the eastern part of town has well-spaced, detached or semi-detached units with front lawns. The areas of superior residences found chiefly on the higher ground contain widely spaced houses with landscaped gardens and a driveway indicating car ownership.

Institutions and open spaces are found in the residential areas. West of Christ Church Park is the hospital, near which are many doctors' offices. On the eastern edge of the town are the poor house, the isolation hospital, and the mental hospital (from north to south). The cemetery east of Christ Church Park has been the town burial ground since the closing in 1855 of the areas attached to old churches in central Ipswich. (Park in Figure 2 includes cemeteries and playing fields as well as parks proper.) Most of the parks were once private estates; they have been given to the town by public-spirited men of wealth. Vacant lots are rare; open spaces are utilized for allotment gardens, twelve of which are indicated in Figure 2. Each of these gardens is divided into scores or hundreds of individual plots, which are rented to town-dwellers for the raising of vegetables. These allotment gardens serve as a reminder that although a farming hinterland mothered many of the industries of Ipswich, the town has grown industrially until it is itself an important market for farm produce.

WATER POWER RESOURCES IN BRAZIL

Preston E. James

BRAZIL is rated fourth among all the countries of the world in potential water power resources. It is exceeded only by the Soviet, the United States, and Canada. According to estimates made in 1937, the Soviet possesses a potential water power capacity equivalent to fifty million kilowatts, or almost twice the potential capacity of the United States. Canada is estimated to have about nineteen million kilowatts, and Brazil a little over fourteen million. (Alves de Souza, A. J. "Legislação brasileira sobre energía hidŕaulica e energía eléctrica," *Forças Hidráulicas*, Vol. 1, Belo Horizonte, 1940, pp. 1–26.)

There is a very great difference, however, between potential water power resources, and developed power. In terms of kilowatt-hours per capita of power consumed, Norway is the leading country of the world, followed by Canada, Switzerland, Sweden, and the United States. Brazil stands twentieth in a list of twenty-three countries, with only Rumania, the Soviet, and China below it.

Physical Conditions Affecting Power Resources in Brazil

One reason that Brazil stands so high in potential water power resources is the enormous size of the national territory. It would be surprising indeed if so large a part of the earth's surface did not possess a large proportion of the descending water which might be converted into power. Yet this is not the whole story, for the physical conditions of Brazil contribute to the creation of many unusually fine water power sites.

In the first place, very little of Brazil is a lowland. There are only a few patches of coastal plain along the Atlantic, and very little flat land in the wide area of the Brazilian Highlands. The Amazon Plain is Brazil's largest lowland area, and this narrows to a mere ribbon of flood plain in the section of the river between Manaus and the sea. Part of western Mato Grosso, too, includes the eastern edge of the Paraguay Lowland. (The new Portuguese spelling, officially adopted for Brazil, is used throughout this article.) Most of Brazil is a hilly upland. The highest peaks, located in the southeast, do not quite reach 10,000 feet above sea level. But the rivers which descend from the highlands do so through narrow, youthful channels, interrupted at frequent intervals by falls and rapids. Many of Brazil's large rivers rise in the southeast, inland from Rio de Janeiro, and flow southwest, north, or northwest away from the crest of the Great Escarpment which marks the coastal edge of the highland. The headwaters of the Paraná overlook Santos in the state of São Paulo; the headwaters of the São Francisco are to be found in central Minas Gerais, only about a hundred miles inland from Rio de Janeiro; the large tributaries of the Amazon rise in central Goiaz and Mato Grosso. In each case as these great rivers descend from the highlands they drop over falls.

The Paraná River, which forms the western boundary of the states of São Paulo and Paraná, flows through the center of a great lava plateau, formed by the successive outpouring of flows of diabase. The very resistant lava forma-

tions form prominent cuestas all around the margins of the Paraná Plateau, and give to the land forms of this part of Brazil a notably tabular profile. The lava plateau extends southward as far as the middle part of the state of Rio Grande do Sul, just north of Porto Alegre, and even farther to the south in the western part of Uruguay. The town of Salto in Uruguay is located where the Uruguay River makes its final descent from the plateau. The western margin of the plateau crosses the Paraná a little west of the Argentine town of Posadas, and continues northward through central Paraguay and central Mato Grosso. From the western edge of the plateau, near Posadas, the Paraná River has cut a deep, youthful gorge back into the region of the diabase, a gorge which has now been extended as far as the famous Guayra Falls of the Paraná (known in Brazil as the Cachoeira de Sete Quedas) located at the northeastern corner of Paraguay. The rivers which drain westward from near the coast of Brazil toward the Paraná all descend over falls and rapids as they approach the main stream. Perhaps the best known falls of South America are those on the Rio Iguassú, on the southern border of the state of Paraná. But there are many other falls and rapids on the Paraná tributaries, for these rivers have steep profiles wherever they cross the diabase formations.

The ancient granites and gneisses which form the basement rocks of the Brazilian Highlands are also very resistant to river cutting. These rocks are weak to the processes of weathering under warm, moist climatic conditions, and are deeply decomposed on the upland itself. The surface of the "crystalline hilly upland" is gently rounded, with broad interfluves and narrow V-shaped valleys. But these same rocks prove very resistant to river cutting, and where the streams descend over the margins of the highlands to the sea, or to the Amazon, their profiles are steep. All the Amazon tributaries from the Madeira eastward are interrupted by falls within a hundred miles or so of the main river. The São Francisco descends over the Paulo Affonso Falls on the border of the states of Baía and Pernambuco, in the northeast. Similarly, the short streams which descend directly to the Atlantic from central and southern Minas Gerais, or from the state of Rio de Janeiro, drop over many rapids as they approach the sea—notably the Rio Paraíba, east of Entre Rios, and the Rio Doce, in the eastern part of the state of Minas Gerais.

The climatic conditions are fundamental to an understanding of the characteristics of these rivers. The only part of Brazil which is subject to droughts is in the Northeast; elsewhere the rainfall is moderate to abundant. In the southern states, from southern São Paulo southward, there is no dry season; but toward the north, in the interior, there is a marked dry season in June, July and August. The fluctuations in flow, therefore, are important in those streams which rise in the interior of the Southeast; and these fluctuations are accentuated by the fact that the forests which once clothed most of southern Minas Gerais and the neighboring states have been largely cleared away. The potential water power is determined, in Brazil as elsewhere, by the low-water flow. (Fonseca Costa, E. L. da. "Richesses minérales et houille blanche au Brésil," *Ann. de géog.*, Vol. 41, 1932, pp. 618–630.)

Power Development

Estimates of potential water power resources, however, are not very important without reference to the people

who might make use of power. The great Iguassú and Guayra Falls, spectacular as they may be, and impressive as may be the figures of the potential power available there, are in reality of little value. Hydroelectric power cannot be sent over transmission lines much more than 250 miles. Within a radius of 250 miles of these places there are no industrial towns to make use of electric power. Talk of the establishment of great industrial centers in the future in these remote and isolated places remains largely in the field of real estate promotion. To develop power, the resource must be found nearer the established centers of Brazilian population. The map of population is of more basic importance than the map of waterfalls in any attempt to interpret the potential power reserves of a country like Brazil. And this map brings out the fact that most of the Brazilian falls are located in places which are too remote from established settlements to be counted, in reality, as potential power sites in the predictable future.

Nevertheless, Brazil possesses in the settled area some very fine power sites. One of the greatest power installations in Latin America is to be found at Cubatão, near Santos, in the state of São Paulo—built to serve the great industrial metropolis of São Paulo. A reservoir has been built at the very crest of the Great Escarpment, which in this section is known as the Serra do Mar. Because of its position at the headwaters of the Rio Tieté, a tributary of the Paraná, the reservoir is filled in large part by the very heavy rainfall of this zone—an average of more than 150 inches. It is also filled in part by pumping water up from the Tieté Valley near São Paulo city, a rise of only a few meters. The water is dropped over the face of the escarpment 725 meters to the power plant located on the coastal lowland in back of Santos. At the plant at Cubatão, there is a potential capacity of 750,000 horsepower, which is sufficient to take care of any predictable future needs of the city of São Paulo—the largest industrial city of Latin America. (Billings, A. W. K. "Water Power in Brazil," *Engineering Journal*, Vol. 13, 1930, pp. 493–503.)

There are numerous other smaller power developments in São Paulo state, and in the territory inland from Rio de Janeiro. In many cases, these small power sites are now linked together by transmission lines. This part of Brazil is superbly endowed with potential sources of hydroelectric power, and the utilization of power in this region has advanced steadily since the first plant was built at Juiz de Fora in 1889.

POWER DEVELOPMENT BY STATES

In all of Brazil in 1937 the production of power was estimated as 1,044,700 kilowatts. (Alves de Souza, A. J. "Legislação brasileira sobre energía hidráulica e energía eléctrica," *Forças Hidráulicas*, Vol. 1, Belo Horizonte, 1940, pp. 1–26.) Of this, 884,500 kilowatts were produced from water power, and 160,200 were produced from steam power. The chief concentration of power plants depending on steam was in the state of Rio Grande do Sul, where there are coal mines of fair quality, and where the political leaders have adopted the policy of giving special assistance to the support of the coal mining industry. Among the Brazilian states, São Paulo was far in the lead in electric power developed, having an estimated 501,800 kilowatts. The territory inland from Rio de Janeiro, mostly in the state of that name, was second, with 231,400 kilowatts, and Minas Gerais was third with 111,700. The remaining 199,800 kilowatts were derived from many small scattered power sources.

The following table shows the proportion of developed power in the major regions of Brazil:

	Per Cent
The North	1.9
The Northeast	7.7
The Southeast	34.8
São Paulo	48.0
The Central states, tributary to São Paulo	0.7
The South	6.9

THE CÓDIGA DE ÁGUAS

Water power development in Brazil has been dependent in large part on the investment of foreign capital. The Brazilian-owned power plants are small and of local significance. Two large power companies, one owned in Canada, the other owned in the United States, dominate the scene in the places where power development has gone forward significantly. The foreign-owned companies are especially interested in the policies announced for the control of power development as announced by the Federal Government. The so-called *códiga de águas* consists of a decree issued by the government of Brazil on the 10th of July, 1934, and a "decree-law" dated November 11, 1938.

The *códiga da águas* contains eight chief provisions, which may be briefly characterized as follows:

1. The sources of power shall remain inalienable national property.

2. Development of the sources of power shall be on the basis of concessions granted by the Federal Government, and in some special cases by the states.

3. Concessions are to run only for a period of 30 to 50 years, at the end of which period the rights shall return to the nation with or without indemnification.

4. Existing concessions shall be revised to fit the new code.

5. Rates shall be adopted to give reasonable returns to the companies.

6. The Federal Government can, at any time for the public good, cancel an existing contract, repaying the amount of the investment less depreciation and amortization.

7. The Federal Government can order the linking of transmission lines between different companies if this seems to be for the public good.

8. The Federal Government shall keep a close watch over the operations of the power companies in order to: a, insure adequate service to the public; b, guarantee reasonable rates; and c, guarantee financial stability and avoid the manipulations of holding companies and other activities detrimental to the consumers.

In order to provide for the supervision of the power companies and to make studies regarding future power developments, the Federal Government in 1939 organized the *Conselho Nacional de Águas e Energia Electrica*. This council now has administrative supervision over this aspect of the Brazilian economic life.

THE FLORIDA CITRUS CROP

Warren Strain

LITTLE is definitely known as to when or how citrus fruits were introduced into Florida. It is probable, however, that Spanish and Portuguese explorers very early brought oranges from the Mediterranean, for at the time of the first permanent settlement in Florida, the orange was already established and practically growing wild. It has been suggested that seeds might have been scattered by Indians who obtained the fruit from the trees planted by these early explorers. Orange trees thrive in this humid subtropical type of climate and their adaptability to a variety of soils soon led to the development of commercial citrus production in many parts of the state.

During the early period of citrus production, oranges were the only fruit of importance. There was a large number of varieties and little attention was paid to favorable locations. Production was haphazard and quality of fruit varied greatly from place to place. Then came the "big freeze" of 1894–95 which almost completely ruined the citrus industry here. There were two notable outcomes from this disastrous freeze: (1) Much more attention was paid to locating the groves in more favorable places with reference to frost protection, and (2) there followed the development of a few standard varieties which were of much higher quality than was formerly grown. Gradually the industry came back. During the first decade of the present century, citrus production gained great impetus when grapefruit suddenly developed as a popular breakfast fruit.

The importance of citrus fruits to Florida is reflected by the fact that these fruits account for about one-third of the value of all agricultural products in the state. Although some citrus fruits are produced in most parts of Florida, commercial citrus groves group themselves into three major regions of production: (1) the Central Ridge region; (2) the West Coast, especially around Tampa Bay, and (3) the Indian River region along the east coast. Figure 1.

Frost Control

The most important factor in limiting the location of citrus groves in Florida is freedom from excessive cold. The well-drained and rolling uplands, pitted by karsts or sinks in the limestone region of central Florida, are commonly referred to as "high pinelands." These are by far the predominant areas utilized for citrus trees in the state and constitute at least seventy per cent of the present acreage. These uplands support a natural vegetation of long-leaf pine, live oak, turkey oak, and blackjack oak, a fact which is indicative of the natural infertility of the soil. These rolling uplands are favorite sites for the groves, since they reduce frost hazard by providing adequate air drainage. Such sites are greatly enhanced if they are on the south side of a lake (Figure 6). Presence of the body of water tempers the cold north winds and thereby greatly reduces possibility of loss due to freezing. It is interesting to note that in the three counties which have the greatest citrus acreage, there are over four thousand

named lakes and many smaller ones. So effective has the natural protection been that less than ten per cent of the groves have artificial methods of frost control. Some oil heaters, comparable to those in operation in California, are used. A few growers have piles of wood distributed through their groves for use as fuel for frost prevention. In some groves in the northern part of the region young trees are set out on mounds approximately a foot high

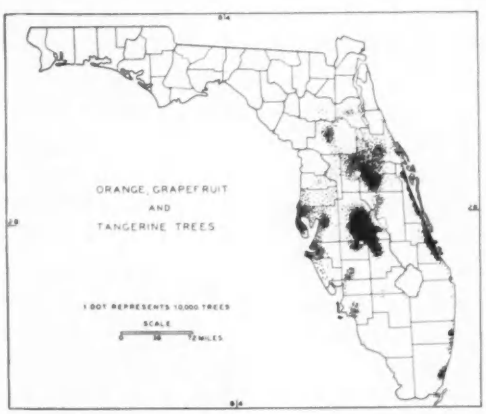

FIGURE 1.—Commercial citrus groves group themselves into three major regions of production: (1) Central Ridge Region; (2) around Tampa Bay, and (3) along the east coast.

further to facilitate air drainage. Most citrus growers take a chance on not having their crop damaged by cold, since loss of an occasional crop is no more costly than purchase and maintenance of orchard heaters.

Along the east and west coasts of the peninsula, where influence of the ocean is much more pronounced, not so much attention is given to the problem of air drainage, and groves occupy areas commonly referred to as low hammocks, palmetto flatwoods, grassy flatwoods, and prairies, depending upon the natural vegetative growth, drainage conditions, and topography of the land.

DROUGHTS AND IRRIGATION

Inadequate moisture in the production of citrus crops is second in importance only to frost protection and has given Florida growers reason for much concern. The average annual precipitation would be adequate for citrus growing if it were evenly distributed throughout the year. However, it should be noted that approximately sixty per cent of the rainfall occurs during the four months from June through September, and during the rest of the year the precipitation varies greatly from month to month (Figure 7). Frequently large quantities of fruit are lost because of insufficient rainfall at the opportune time. The two periods during which most groves suffer from lack of moisture are in the spring months of March, April, and May and again in the fall and winter months of November, December, and January. During the later period early and mid-season fruits are maturing and a dry period then makes the fruit too soft for harvest, and loss due to dropping is great. A similar loss is experienced with late fruit if a drought occurs in spring. In addition, a spring drought affects the bloom for the next year's crop. However, losses from spring droughts are smaller than from inadequate moisture in fall and winter because it is possible to obtain a June bloom and thereby harvest a good yield if drought does not again occur in the following fall and winter months. The fact that most citrus soils in Florida do not have great capillary power to attract moisture from the free water below makes droughts even more disastrous.

While irrigation is practiced on less than twenty-five per cent of the groves, it is rapidly spreading now that the experimental stage has proved that it is

economically desirable. This practice in Florida has attracted much less attention than in California, since Florida growers are not so completely dependent upon it. Furthermore, a much less elaborate system is found in Florida. Portable pumps and pipes are used to provide a sprinkling system, one outfit serving several groves during a season (Figure 8). Therefore, it is not so readily visible to the tourist or casual visitor. Groves adjacent to lakes where water is abundant and easily accessible are having the rainfall supplemented by irrigation in increasing numbers.

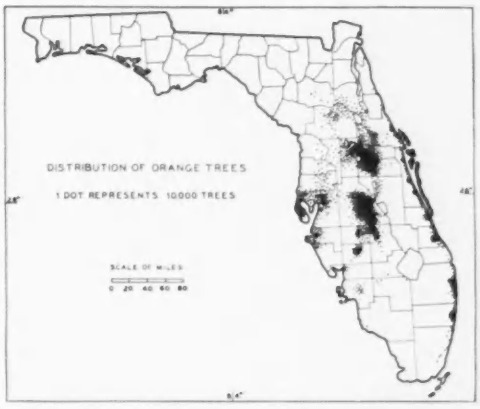

FIGURE 2.—Forty-five per cent of the orange trees in Florida are found in Polk, Orange, and Lake counties, in the Central Ridge Region. The low and cold lands adjacent to the Withlacoochee River breaks the continuity of this region.

SOILS

As suggested before, the soils in the citrus areas of Florida are among the most infertile in the country. They are sandy, low in clay and organic matter, and subject to fifty inches of rainfall per year. Furthermore, they are subject to leaching throughout the whole year, since there is no period when the ground is frozen. For a long time growers realized that the soils were deficient in elements necessary for the highest fruit production but it has been only within the past few years that systematic studies have been made to determine the deficiencies. As a result of this lack of definite knowledge, many erroneous ideas and practices sprang up. Growers realized that fertilization of the soil was essential for continued production of fruit but, unfortunately, unfavorable conditions were frequently aggravated because proper fertilizers were not used.

In the past, nitrogenous materials were rather heavily applied over a circular area slightly larger than the actual spread of the tree. This continued application of nitrogenous material led to acidity in the soil which in turn led to excessive leaching of the copper. Deficiency of copper resulted in a brown excrescence of hardened gum in the rind of the fruit, and oranges frequently split while still on the trees. In the case of grapefruit, a copper deficiency leads to lopsided fruit with pockets of gum in the rind and about the seed.

Likewise, excessive application of lime results in fixing zinc in an unavailable form in the soil. This deficiency

FIGURE 3.—Since grapefruit and orange trees are frequently planted in the same grove it is natural that the same general pattern of distribution should prevail. The importance of the area adjacent to Tampa should be noted.

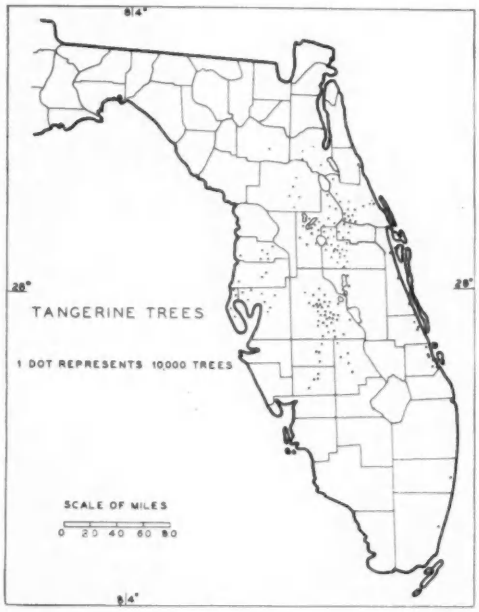

FIGURE 4—Tangerines may be considered a minor citrus crop when compared with oranges and grapefruit. It will be noted, however, that the same general pattern of distribution prevails.

results in yellowing of leaves and produces a fruit which is woody and has very little juice. The taste is insipid due to reduced acid content. Few fertilizers used in Florida have had any appreciable amounts of magnesium, an element required in large quantities to prevent bronzing of leaves and dropping of foliage during the fruiting season. This dropping of leaves leads to rapid dropping of fruit and reduced yield the following year. These are just a few examples to indicate the problems involved.

A tree may receive insufficient quantities of an element for a number of reasons, such as: (1) the element may become fixed in an unavailable form in the soil due to chemical combinations; (2) it may be leached from the soil, such leaching frequently being aggravated by application of too much acidic fertilizer; (3) it may be "cropped out" as is frequently true in the case of magnesium; (4) extreme droughts, and (5) poorly adapted root-stocks almost always cause an intensification of deficiencies.

Now that the deficiencies and their symptoms are recognized, much progress is being made in correcting them. Of course, fertilizers will help, but a much more rapid and effective way to secure results is by application of the deficient substance in the form of spray. This is the most important reason for spraying. Fortunately for the growers, there are no "chewing" insects which attack the citrus groves. It is interesting to note that fertilizers and amendments account for almost forty per cent of the cost of production and this item is the largest single item in the expense account. However, even this is about half the minimum cost for fertilizers in California.

FIGURE 5—Three-fourths of the lime trees in Florida are found in a small area southwest of Miami and Key Largo. Since these trees are very sensitive to cold they are limited to this southern area.

HARVEST

The time of harvest depends upon two factors—variety and demand for the fruit. There are two major varieties known in trade as (1) early and mid-season, which matures in the autumn and early winter, and (2) the late variety which matures in late winter and spring. The fruit is usually left on the trees until there is a demand for it, since it has long been recognized that citrus fruits keep much better when left on the tree than when placed in cold storage.

The harvest in Florida is very similar to that in any other citrus area. First the fruit must be tested for maturity, since it is not possible to determine this by outward appearance. To be mature, there must be a specified solids-acid ratio and once the fruit is harvested, there is no process or treatment known whereby it can be forced into legal maturity. The field foreman is in charge of operations in the grove and is responsible for testing the fruit for maturity, estimating the crop so that at any time during the shipping season he can give the approximate number of boxes of fruit remaining on the trees, and overseeing the picking crews. The term "picking" the fruit is a misnomer, since practically all the oranges and tangerines are cut from the trees by means of clippers especially designed for the purpose. Grapefruit, however, can be pulled from the trees without much danger of tearing the rind. One advantage of pulling grapefruit is that it removes the "collar" or calyx points and thereby greatly reduces the possibility of stem-end rot, a form of decay which is most serious to citrus fruit grown in humid regions.

In groves where trees are well loaded with fruit, the ordinary experienced picker can harvest about eighty boxes of oranges or one hundred twenty boxes of grapefruit per day. However, size of the fruit and weather conditions may cause considerable variation from the above amounts. Great care must be taken continually to prevent breaking of the skin of the fruit for this would invite rapid spoilage and decay. In some more progressive organizations, all workers handling the fruit are required to wear gloves to prevent their finger nails from injuring the tender skin. Each picker is equipped with a picking sack which is suspended from the shoulder. When a picker has filled his sack, he empties it into field boxes which have been distributed through the groves. These field boxes are usually constructed of cypress because of the relative lightness and durability of that wood, although pine is sometimes used. However, an empty cypress box weighs about seventeen pounds.

FIGURE 6.—In the Central Region, the karst topography provides slopes which facilitate air and water drainage for the citrus groves. Small lakes, such as that seen in the foreground to the left, temper the cold north winds and thereby reduce the frost hazard. (Courtesy of Florida Citrus Commission.)

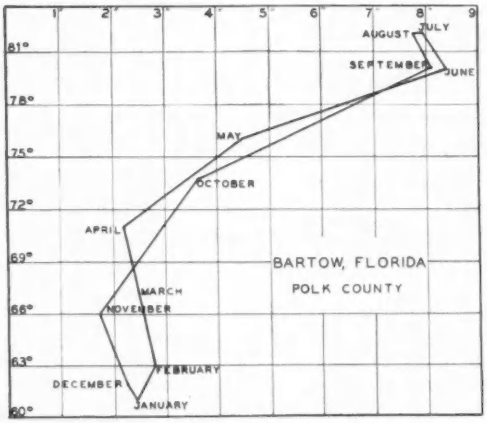

FIGURE 7.—The rainfall and temperatures at Bartow are representative of the citrus regions. The rainfall, in inches, is indicated across the top of the climograph, and the temperatures, in degrees Fahrenheit, are shown on the side.

The boxes of fruit are usually transported to a packing house in a nearby town by means of motor trucks.

PACKING HOUSE OPERATIONS

Although the functions of packing houses in Florida and California are the same, the houses themselves differ in several minor details. In Florida, for instance, packing houses are rarely constructed with basements while in California, basements are in general use, especially for the non-refrigerated storage of lemons. Furthermore, California packing houses have more mechanical contrivances than do Florida houses. The latter condition may be partially explained by the higher wage scale prevailing on the west coast.

With minor variations, the following steps are taken in preparation of fruit for market. Upon its arrival at the packing house, the boxes of fruit are dipped into a vat of borax solution. This antiseptic treatment is very effective in reducing loss due to decay. In this bath frosted fruits are detected, since frost reduces the juice content in the fruit and it therefore floats. From this antiseptic bath the boxes are taken to degreening rooms where they are left for a period of thirty-six to sixty hours. Frequently oranges and grapefruit that have reached maturity appear to be immature because the green pigment masks the yellow or orange-colored pigments. A good example of this is found in the Valencia oranges which develop almost full color in the winter but do not mature until spring. When new growth starts in the spring these oranges "regreen" and if allowed to remain on the trees until they are fully ripe, they appear immature. By the introduction of ethylene gas into the room where the fruit is stored, the green color disappears and thereby unmasks whatever shade of orange may be in the rind. It should be pointed out that this treatment does not produce or change the orange color which is in the rind but just unmasks it.

During the fifteen minutes following removal of the fruit from the degreening room, it passes in rapid succession the various steps in its preparation for market. First it is dumped onto the conveyor belt (Figure 9). In Florida this is done almost entirely by hand, one man dumping an average of three or four boxes per minute. The dumping belt is generally of the roller type so that twigs, leaves, and other litter may fall through and be removed. At the end of the dumping belt are short transverse scrubbing brushes upon which streams of water are sprayed. This takes off much of the loose dirt as the fruit passes over the brushes. Next, the fruit falls into a soaking tank in which cheap soap powder has been added to the water which is kept warm by steam coils in the bottom of the tank. As it is carried from the soaking tank it again passes over brushes which remove any dirt loosened by the soaking process. Then clear water is sprayed on the

fruit to give it a final rinse. Large fans direct blasts of warm air on the conveyor belt to evaporate the excess moisture. The fruit is then waxed and polished. Paraffin is the most common polishing agent although carnauba wax, pine oil, and rosin compounds are sometimes used. The polishing is done by brushes which rotate over cakes of paraffin, or liquid wax may be sprayed onto the fruit. When color is added to oranges, it is applied at this time. After the fruit has been cleaned and polished, it is graded according to surface appearance and size, packed, and sent to the cooling rooms where it remains for a twenty-four hour period. Thus when the fruit is shipped, it starts at a temperature of about thirty-six degrees.

TRANSPORTATION AND MARKETING

Practically all the fruit is shipped soon after it is harvested. Railroads and steamship lines transport the greater percentage of the crop but with the development of systems of all-weather highways throughout the country, trucks are playing an increasing rôle in distribution of citrus fruits. Figures 10, 11, and 12 show monthly shipments of oranges, grapefruit, and tangerines by respective modes of transportation.

From Figure 10, it will be noted that although a few oranges are shipped from Florida in September, the real season begins in October and shipments steadily increase in amounts through December. The importance of Thanksgiving and Christmas trade is definitely reflected. It is during this period that early and mid-season oranges are on the market. The second peak in shipments occurs in March when the Valencias begin to mature. While railroads still provide the major method of transportation for oranges, it is interesting to note that both ships and trucks are becoming increasingly important at the expense of railroads. Especially between Thanksgiving and Easter are truck shipments important.

In the case of grapefruit marketing, it will be noticed that shipments steadily increase from September to March when the peak is reached and from then on, they decline steadily. During the first five months of production, the Duncan grapefruit occupies a dominant position and since this is a seedy variety, it does not find the ready market that seedless varieties enjoy. By March the Marsh Seedless grapefruit is ready for market. It is interesting to notice that a much smaller percentage of grapefruit is shipped by truck than was true in orange shipments. One possible explanation for this is the larger size of grapefruit which would reduce the number hauled in any one load and thereby reduce profits to truckers. A second reason is that grapefruit has not yet approached oranges in popularity, and peddlers are more inclined to risk selling a truckload of oranges by retail than a truckload of grapefruit.

From Figure 12 it is apparent that

FIGURE 8.—The rainfall is supplemented by portable irrigation systems. Water is pumped into these pipes until the ground is saturated and then the pump and the pipes are moved to another grove. (Courtesy of Florida Citrus Commission.)

most of the tangerines are marketed during the Christmas season.

PROBLEM OF OVERPRODUCTION

A few years ago a group of ambitious real estate speculators went up and down the citrus regions of Florida and Texas setting out grapefruit groves by the hundreds and thousands of acres, not for the purpose of growing grapefruit but to sell the land. Now that these groves are coming into bearing, the problem of over-production is becoming increasingly serious. The importance of this problem may be emphasized by a study of Figure 13 which indicates that only a small percentage of the Texas acreage has yet reached full bearing. Competition is thus forcing the Florida producer to provide a product of higher quality and at a lower cost. Under present marketing standards about eight per cent of the oranges, fourteen per cent of the grapefruit, and ten per cent of the tangerines remain in the groves where they are grown, and from three to four per cent of the fruit taken to packing houses finds its way to the cull pile. It is estimated by leading fruit men that ten per cent of the fruit now marketed is of such low quality that it does not pay marketing expenses. These lower grades are, of course, thoroughly wholesome in every respect but due to outside appearances, they are discounted heavily on the fresh fruit market. Thus it may be seen that with increasing competition, approximately one-fourth of the fruit produced in Florida must find a new outlet, other than the fresh fruit market.

FIGURE 9.—A modern packing house. In the foreground are the field boxes filled with oranges. The oranges are dumped onto the conveyor belt just back of the boxes and start on their preparation for market. The empty boxes are returned to the outside by another belt. Near the center of the picture is a battery of fans for drying the washed fruit. (Courtesy of Florida Citrus Commission.)

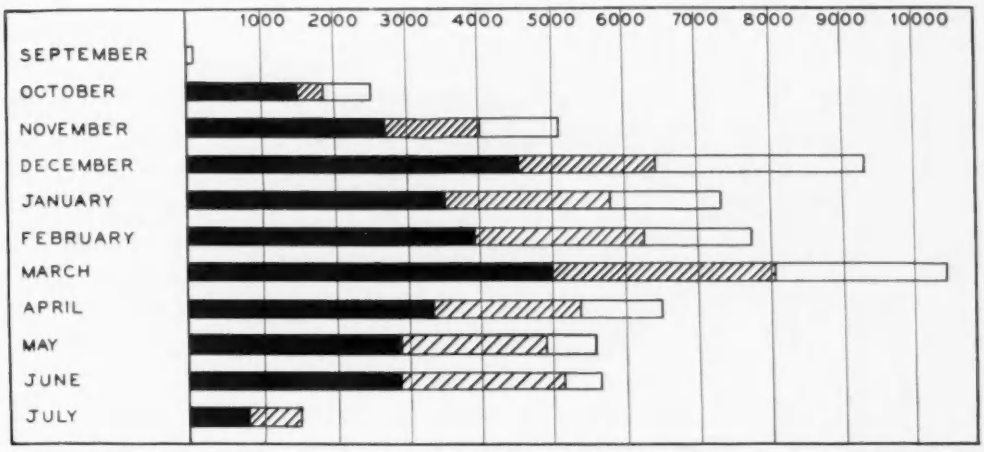

FIGURE 10.—Movement of oranges from Florida during the 1938–39 season in car lots or equivalents. Solid bars indicate rail shipments, ruled bars represent boat shipments, and open bars indicate truck shipments. (Data from Florida State Marketing Bureau.)

CANNING INDUSTRY

The canning industry is helping to reduce this surplus, especially in grapefruit, in at least three distinct ways: (1) It removes lower grades of fruit from competition with better grades in the fresh fruit markets. Canners are able to utilize large quantities of fresh dropped fruit if it is properly harvested and quickly transported to the factory. (2) The marketing season is greatly extended. During the last six months of the 1937–38 season the amount of canned grapefruit and juice sold by Florida canners was equivalent to approximately 2,050,000 field boxes of raw fruit. Thus approximately fifteen per cent of the total Florida crop was sold at a time when it did not compete with fresh fruit. (3) Areas which are too remote from producing regions to receive fresh fruit are now being served by the canned product. Recently canned grapefruit and juice equivalent to 700,000 boxes of fruit, was exported in one season. Although fresh grapefruit cannot be shipped into California, due to quarantine laws, canned goods representing 625,000 boxes of fruit were shipped to the Pacific Coast the same year. In addition, canned grapefruit marketed in out-of-the-way places too small to handle fresh fruit—steamship lines, resorts, and other inaccessible places—represented another 150,000 boxes of raw fruit. Thus at least 1,475,000 boxes were sold in markets beyond the reach of fresh fruit. This represented one grapefruit in every thirteen produced in Florida.

From an extremely small beginning of the canning of grapefruit in a small Miami plant in the fall of 1921, the industry has grown by leaps and bounds. To get a fair conception of the present importance of the industry, it must be realized that in an average year about 8,500,000 cases of sections and juice are packed in Florida. This would, if placed in standard freight cars, make a solid train seventy-three miles long and is equivalent to approximately seven million boxes of raw fruit. The canning plants usually open the later part of November or early December and operate into June or sometimes into July, depending upon the fruit available for canning purposes. The

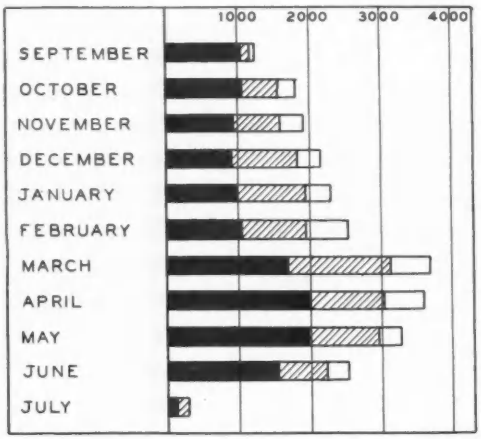

FIGURE 11.—Movement of grapefruit from Florida during the 1938–39 season in car lots or equivalents. Solid bars, rail shipments; ruled bars, boat shipments; open bars, truck shipments. (Data from Florida State Marketing Bureau.)

peak of the pack is reached during the months of January and February. The Duncan grapefruit is most extensively used in the canning of grapefruit sections. Like other early varieties, it is seedy and is, therefore, less popular on the fresh fruit market. Furthermore, seeded varieties are firmer and the sections remain intact whereas seedless varieties have a tendency to disintegrate in the cans. In this connection it is worth noting that practically all the grapefruit in Texas is the seedless variety and therefore offers very little competition with Florida in the canning of sections. However, seedless grapefruit are especially desirable for the canning of juice and it is in this line that Texas becomes the greatest competitor. The demand for grapefruit juice is rapidly increasing.

Oranges are used by the canning industry mainly for juice, although a very small proportion of the pack is canned as fruit cocktail, as salad, and as sections. In the past few years the consumption of orange juice canned in Florida has increased tremendously and in the 1939–40 season amounted to approximately two-thirds of the pack of grapefruit juice. The packing of blended juices, a combination of grapefruit and orange juice, is meeting with favorable consumer acceptance.

Tampa is the headquarters of the citrus canning industry and is the shipping point for the whole state. Prices are quoted F.O.B. Tampa throughout the industry. Over sixty per cent of the pack of grapefruit is shipped by water from this city. Canned grapefruit products shipped through Tampa are second only to phosphate in tonnage and are almost four times as valuable as the phosphate. Two plants which manufacture tin cans are located here and the imports of canning supplies, such as cartons for the cans, sugar, and tin plate, make up important items in the trade of the port.

BY-PRODUCTS OF CANNING

In an average season refuse from canning factories amounts to about 65,000 tons and as demand for canned fruit and juices increases, quantity will increase. During the year 1932 a very limited amount of citrus pulp and peel from two canning factories was dried and brought to the Florida market as dairy feed. This feed is a good source of calcium, an element often

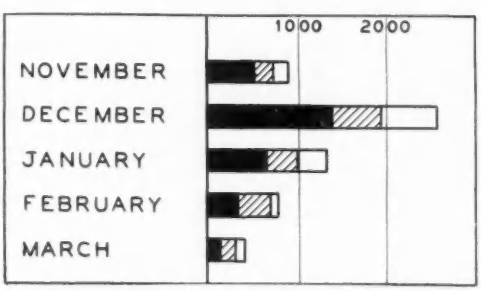

FIGURE 12.—Movement of tangerines from Florida during the 1938–39 season by car lots or equivalents. Solid bars, rail shipments; ruled bars, boat shipments; open bars, truck shipments. (Data from Florida State Marketing Bureau.)

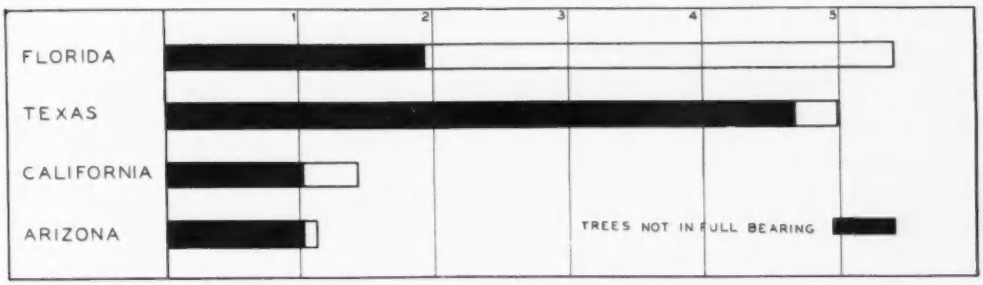

FIGURE 13.—The number of bearing grapefruit trees by the four leading states as of July 1938. Numbers are in millions of trees. (Data from Florida State Marketing Bureau.)

deficient in dairy rations, and compares favorably with dried beet pulp in digestible nutrients. The addition of molasses to the dried citrus pulp is increasing its popularity among dairy farmers. Four of the six plants manufacturing dairy feed from citrus pulp are located in Polk County.

LIMES AND LEMONS

Although lime trees have been planted in twelve counties in Florida, seventy-five per cent of the trees are found in a small area southwest of Miami and on Key Largo. Lime trees are very sensitive to cold and even those groves located in exceptionally well protected areas suffered greatly during the freezes of the last two years. Princeton, located about twenty-five miles southwest of Miami, is the major market center for limes. Picking is begun in May and lasts until December but during the months of September and October the greatest quantity is harvested.

Lime production on Key Largo is especially interesting since lime trees grow right out of the coral, and broken pieces of coral are piled up around the tree to hold it in place. Cultivation is impossible due to the absence of soil, but usually the weeds are slashed twice each year with a machete or large knife. Since there is an eight-month harvest season, it is possible to see blossoms, green fruit, and ripe fruit on the same tree, a feature which never fails to impress the visitor from the North. The lime industry here received a severe set-back by the tropical hurricane of 1935 which uprooted many trees. However, the industry is again establishing itself.

Statistics on movement of limes out of Florida comparable to those for oranges, grapefruit, and tangerines are not available. The State Marketing Bureau explains this by stating that production of limes has not yet reached sufficient proportions to justify the establishment of official agencies to tabulate regular information in connection with them.

Lemons are even less important than limes as a commercial fruit in Florida. The few lemons that are produced are grown in the same general area as limes, since they too are very sensitive to cold. Dr. Camp, the horticulturist in charge of the Citrus Experiment Station at Lake Alfred, Florida, summarizes the situation by stating, "There have been some plantings of what is known as the Perrine lemon, a hybrid, but practically all of them have passed out of existence due to diseases and cold. If they are not completely out of production, they are so badly injured that they are not a factor in the commercial situation."

SUMMARY

Freedom from frost is the most important factor in locating the citrus groves in Florida. Along the coasts, the ocean modifies winter temperatures while in the interior, slopes provide air drainage and lakes temper cold north winds. Better adaptation to soil conditions and more extensive irrigation will undoubtedly improve quality of the crop. The most serious problem facing citrus growers is over-production and this is being effectively met by expanding the canning industry.

SYNTHETIC PRODUCTS AND THE USE OF SOY BEANS

Joseph A. Russell

THE sources of basic raw materials are shifting with the development of industrial chemistry. In the retorts and laboratories of the chemist is the germ of new distributions of the products which the geographer studies; new uses for old raw materials; and entirely new substances which may change the industrial foci of the world. It is the purpose of this paper to explore some of the geographic implications of synthetic products, particularly the use of soy bean derivatives by the Ford Motor Company.

Before the World War of 1914–1918 industry was based on naturally processed materials. Sheep, plants, and worms supplied the fibers for our textiles. Bone, hides, ores, horn, the sap, bark, and latex of trees, the secretions of insects and animals, and countless other products supplied the sinews of manufacturing establishments. Industrial progress was confined to progress in design and building, and losses from rust, rot, fire, pests, disease, and faults inherent in the natural raw material imposed definite limitations on manufacturers. Machines of transportation were overburdened with weight in order to acquire strength, and this one fact slowed the development of rail, highway, and air communication.

Exigencies of the War provided a stimulus to industrial chemistry, a science which deals with the ultimate composition of things as distinguished from their mechanical composition. Progress based on chemistry is, then, fundamentally different from progress based on mechanical change. For thousands of years we have been able to spin fibers of cotton, wool, flax, or silk into yarn and weave the yarn into fabrics. This was a mechanical process, and the product remained cotton, wool, flax, or silk, and the properties of the resulting textile were those of the basic material. When, however, the chemist mixes acetic acid with cotton, an entirely new third substance is obtained. This new material, cellulose acetate, resembles neither cotton nor acid, and can be fabricated into goods for which neither of its parent materials were entirely suitable.

Shifts in Basic Raw Materials

Under the leadership of chemistry, industry turned from the age-old task of making *better* products of wood, metal, leather, and bone, to the problem of solving the question of the composition of those materials. Manufacturers began to look at cotton, oil, coal, wood, peanuts, soy beans, and other natural products not as raw materials in themselves, but as compounds of raw materials. Coal became not merely a fuel, but an almost limitless source of carbon. Cellulose, a fibrous substance, makes up the cell membranes which are the main structure of all trees and plants. When treated with certain chemicals, almost endless new products not found in nature can be born of cellulose. Some 300,000,000 pounds of wood pulp, mostly from spruce, fir, and hemlock, are used as a base for cellulose products in the United States annually. Lignin, which is the binder of cellulose in plants, together with cereal hulls, cull fruit, milk, and many other materials have been adapted to multiple uses.

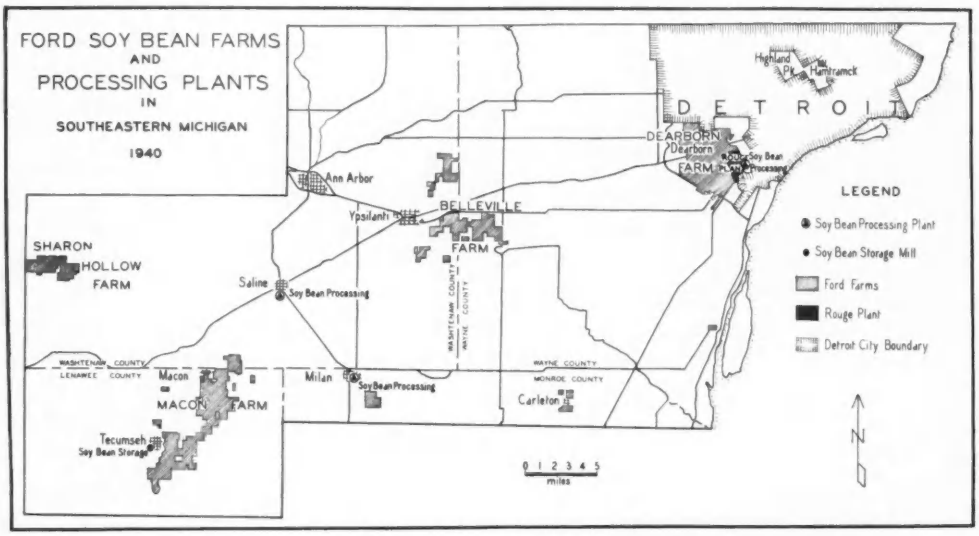

FIGURE 1.—Location of the Ford soy bean projects. The Ford Motor Company has acquired large blocks of land in southeastern Michigan to produce soy beans and other crops. The cultivated fields of the Dearborn Farm are not continuous, but are scattered throughout the city of Dearborn and along the highways leading into the city.

The pioneers in the field of industrial chemistry first attempted to find substitutes for the materials which had become scarce or costly. Dyes, horn, ivory, and bone were replaced by chemical materials. Many other natural raw materials subsequently served as patterns for new products. Cellulose acetate rayon, originally conceived as a silk substitute, now makes up nine per cent of the textiles of the United States. On its own merits it has replaced silk in various ways, and has had a profound effect on American-Japanese economic, if not political, relations. Artificial leather has released to other uses thousands of acres of land which would have been used to pasture the cattle necessary to supply leather.

In the twenty-three years since the end of the World War, more than 200,000 entirely new compounds have been developed. Many of these are modeled after natural substances, but more are without counterpart in nature. Few fields of industry remain untouched. Camphor, formerly a practical monopoly of Japanese Taiwan, is now made from southern turpentine. Chile, which at the beginning of the present century supplied more than 80 per cent of the world's saltpeter, found a competitor in nitrates synthesized from the air, and is now limited to approximately 15 per cent of the world market. Synthetic rubber (elastomers) made from coal or oil, water, salt, limestone, and sulphur, is in some respects superior to the natural product. Silk, bristles, gut, and other products face a rival in nylon, which has many of the properties of all, and adds other desirable characteristics of its own. Thus Chile, Japan, the U.S.S.R., China, and the Middle East have already felt an economic loss resulting from the development of synthetics in America.

Industrial chemistry is a strong ally of the conservation movement. The life of our petroleum reserves has been extended by the discovery of more effective methods of extracting gasoline and oil from crude, and by finding new uses for petroleum by-products. Hun-

dreds of marketable articles are made from formerly wasted refinery by-products. Over 100 products including buttons, creosote, phonograph records, baking powder, aspirin, and perfume, are synthesized at high pressures from coal, air, and water. Other exhaustible and non-replaceable minerals are being saved through the development of alloys which are lighter and will last longer than their predecessors. The annual drain on our forests is being reduced by a more complete utilization of wood, lignin, and forest by-products. Many plastics are being substituted for metal articles.

PLASTICS

When the chemists broke down nature's raw materials and re-combined them into new products, the resulting combinations were called plastic compounds. Manufacturers put these compounds into molds, dies, and presses, and under heat and pressure, or by injection, rolling, or extrusion, form them into a variety of designs and shapes. Telephones, steering wheels, safety glass, radio cabinets, ash trays, buttons, rods, sheets, tubes, surgical thread, fishing leaders, stockings, suits, and sanitary wrappings are but a few of the hundreds of uses of plastics which are a part of our everyday life.

The properties of plastic materials are flexible, and new combinations can be developed to fit nearly any specification. Plastics are easy to mold and are highly dielectric. They are durable and non-corrosive, light weight, and can be permanently colored by impregnation. Some plastics are transparent and possess a glass-like tinkle. Others will take bright and varied coloring. Some have the tensile strength of steel and will outwear steel. Plastics can be made as thin as tissue and lighter than aluminum.

FIGURE 2.—Steam-powered sawmill which is a part of the equipment of the Macon Farm. This farm is highly mechanized because it is used as a proving ground for Ford manufactured farm implements.

They can be drawn finer than silk and made elastic. Some will stop bullets.

In their present stage of development many plastics cost more per pound to produce than the articles they replace. The lowest priced is 14 cents a pound, compared with 1.5 cents for steel, 13 cents for brass, and 18 cents for plate glass. However, plastics possess greater bulk per unit of weight, and finishing costs are lower. In many uses upkeep savings make it profitable to substitute.

INDUSTRIAL CHEMISTRY AND THE FARM

Industrial chemistry has not neglected the farmer. Farm Chemurgy is the application of chemistry to the multiple uses of farm crops. Technicians who labored to increase farm yields have turned to a corollary field, that of finding new uses for the surpluses which have accumulated. Chemurgy will allow the United States to make fuller use of its various soils and climates. Farm surpluses, resulting from increasingly efficient farm techniques, expanding crop acreage, decreasing rate of population growth, loss of export markets, and changes in diet, create a serious problem of rural maladjustment. The automobile and tractor have not only increased yields, but have released between 35,000,000 and 40,000,000 acres

of pasture and crop land which were needed to feed the horses and mules displaced by mechanical power.

Many crops have been studied by the chemist. Forest products, including both cellulose and lignin, foods, soy beans, herbs, medicinal plants, coffee, fruit culls, milk casein, tobacco, cereal hulls, marine products, fiber crops, and general crops have been found to possess industrial potentialities. What is being done with these materials can be done with all of our crops which produce fermentable starches and sugars, which contain fibers of cellulose, whether they be cotton, wood, hemp, or flax, which are rich in protein for plastics or oil for paints.

FIGURE 3.—Threshing on Dearborn Farm land within one mile of the Ford Motor Company Rouge plant. All units of the Ford farms make efficient use of mechanical equipment. Crops from the various units are used as industrial raw materials or as feed for the horses at Greenfield Village, the Edison Institute Historical Museum.

The chief market for many farm crops is already in unusual industrial fields. Joint cost techniques extract glue, gelatine, soap greases, glycerine, fertilizers, medicines, and leather from animals. Starch, dextrine, glucose, solvents, and chemicals are extracted from cereals. About 40 per cent of the cotton crop is utilized in non-textile manufacture. Wood finds multiple uses in paper, turpentine, rosin, lacquers, molded plastics, rayon, and artificial leather. Government research laboratories at Philadelphia, Pa., Peoria, Ill., New Orleans, La., and San Francisco, Cal.; state experimental laboratories, private industry, universities, and other agencies are striving to develop new uses for present crops, new crops for existing and new uses, and profitable markets for farm by-products. The use of a 10 per cent alcohol fuel in 1960 will increase the United States' needs for cereal crops by some 25,000,000 acres. Wood, sugar cane bagesse, potatoes, cereal straws, corn cobs, molasses, and various crop stalks would furnish a fuel supply which is renewable in terms of years instead of geologic ages.

USE OF FARM PRODUCTS BY THE FORD MOTOR COMPANY

It is the purpose of the subsequent discussion to illustrate the use of farm products, particularly the soy bean, by the Ford Motor Company. Other industries could be used equally well to illustrate the use of farm products, but the Ford Motor Company has made a farm-factory integration a definite policy. In 1935 this company paid more than $27,000,000 for the agricultural materials used in the manufacture of some 1,000,000 automobiles. The per car expenditure has been increasing steadily, and experiments now being carried forward indicate a constantly augmented utilization of such products in the River Rouge plant.

Table I indicates the chief farm

TABLE I

FARM PRODUCTS USED BY THE FORD MOTOR COMPANY

Product	*Uses*	*Acreage Needed*
Cotton	Upholstery, tires, brake linings, timing gears, top and curtain material, artificial leather, lacquer, safety glass, battery box, cotton in paper, cellulose in plastics such as choke rod knob, throttle rod knob, cowl ventilator knob, cigar lighter knob, panel ash tray knob, window regulator knob, glove compartment door, radio grill, window reveal moldings, etc.	558,000
Wood	Body construction, shipping cases, paper board, paper body deadener, solvents, wood flour filler used with soy bean plastic resin, etc.	20,500
Wool	Upholstery, gaskets, anti-rust lubricants, floor coverings.	267,000
Rubber	Tires, mountings, hose, gaskets, mats, running board covers, insulation, steering wheels, top material. (203 parts.)	69,000
Cows	Leather, upholstery, gaskets, hide-glues, milk casein glues, stearic acid in rubber compounds, greases, glycerine, soap.	30,000
Flax	Paints, core oil, soft soaps, glycerine.	17,500
Tung Oil	Top material, enamels, varnishes, brake lining.	16,000
Soy Beans	Protective and decorative coating, body finishes, green bond in foundry, plastic resins used in 20 parts such as horn button, light switch, gear shift lever ball, distributor soil base and cover, distributor cap, cut-out case, regulator base, accelerator pedal, timing gears, stearing wheel; stearic acid, glycerine in paint and shock absorbers, etc.	61,500
Swine	Lard for rear axle oil, lubricant, oleic acid for soluble oils, bristles for brushes, etc.	10,000
Corn	Rubber substitutes, top coating material, green bond in foundry, butyl alcohol, solvents.	11,280
Mohair	Goat's hair pile fabrics, window channel fabric.	43,750
Sugar Cane	Alcohol, anti-grease, shock absorber fluid, solvents.	12,500
Jute	Carpet backing, bagging (3,000,000 pounds).	
Pine Pitch	Turpentine, solvent, resin in foundry, paints, lacquers, adhesives (2,060,000 pounds).	
Cork	Gaskets, etc. (250,000 pounds).	
Beeswax	Electrical embedding compounds (93,000,000 bees).	
Castor Oil	Artificial leather, lacquers (240,000 pounds).	
Hemp and Sisal	Rope	
Wheat	Starch in foundry.	

products which enter into the production of a Ford automobile, together with some of the uses of these products, and the amount of land required for their production. The total land needed to grow these commodities is in the neighborhood of 1,200,000 acres, an area about a third larger than the state of Rhode Island.

USE OF SOY BEANS BY THE FORD MOTOR COMPANY

The use of agricultural products by the Ford Motor Company has been the result of a conscious effort to form a closer union between primary and secondary production. In 1930 experiments were inaugurated in Dearborn to determine which crop would most nearly fulfill the requirements of the "agrindustrial age." Wheat, carrots, sun flowers, cabbage, onions, corn stalks, soy beans, and many other products were brought into the experimental laboratories. By December, 1931, $1,500,000 had been expended on these experiments, and the soy bean had been demonstrated to be the most adaptable to the needs of the Ford plant. In 1932, 8,000 acres of soy beans were planted on company owned land. Three hundred varieties of beans were tested, and finally the Manchu and Mandarin types were selected as the best all-around varieties. To date nearly $3,000,000 have been spent on experiments with this crop and its manufacture.

There are several reasons why the soy bean was chosen as the most desirable crop for a farm-factory integration. The three-fold value of soy beans as human food, animal feed, and potential industrial raw material is heightened by prolific and constantly increasing yields under a wide variety of natural conditions. Its leguminous nature as a host to nitrogen-fixing bacteria is an added desirable characteristic. The United

States Department of Agriculture Yearbook of 1937 lists more than 75 separate uses for the bean. Although nearly 95 per cent of the annual soy bean crop of the United States is consumed as human food or as feed, the remaining five per cent is significant in the implications of future industrial use.

SOY BEAN PRODUCTION AND MANUFACTURE IN THE UNITED STATES

Every phase of soy bean production and manufacture has increased during the last decade. Acreage has multiplied from 1,782,000 in 1934 to 10,006,000 in 1939, while the production increased ten fold between 1928 and 1939, when there were some 87,409,000 bushels harvested.

TABLE II

SOY BEAN PRODUCTION, 1928–1937, 1938 AND 1939[1]

(United States and Michigan Totals)

	1928–1937 average	*1938*	*1939 (Preliminary)*
Acreage (acres)			
United States	4,734,000	8,196,000	10,006,000
Michigan	25,000	77,000	148,000
Acreage Harvested (acres)			
United States	1,429,000	3,015,000	4,226,000
Michigan	8,000	35,000	60,000
Yields per acre (bushels)			
United States	14.7	20.2	20.7
Michigan	12.3	16.0	16.0
Production (bushels)			
United States	21,833,000	62,729,000	87,409,000
Michigan	103,000	560,000	960,000
Price per bushel			
United States		$.68	$.77
Michigan		$.73	$.80
Value on Farm			
United States	$38,178,000 (1937 only)	$42,376,000	$67,488,000

[1] *Agricultural Statistics*, 1940, United States Department of Agriculture, Washington, D. C., p. 307.

FIGURE 4.—Field of soy beans at Macon Farm. This picture, taken August 1, 1940, shows the luxuriant foliage of the manchu plant which is left in the fields as green manure.

(Table II). The twenty-six establishments manufacturing soy bean products in 1937 increased to 47 in 1939, and the value of the meal and oil from these establishments swelled from $24,312,433 to $43,946,647. In 1939 the farm value of soy beans was $67,488,000 an increase of $25,000,000 over the 1938 value. Much of the farm and acreage expansion has taken place on Corn Belt land which was released from oat production by the loss of 13,000,000 horses and mules from the American scene between 1919 and 1937. The 1939 oat area of Iowa, Illinois, Indiana, and Ohio was 2,996,000 acres smaller than the 1928–1937 average, and the nation as a whole lost 4,382,000 acres of oats during this period. Soy beans gained 5,272,000 acres.

INDUSTRIAL USE OF SOY BEANS

The industrial use of soy beans is based on the oil and meal which result from its processing (Table III). The meal is composed of 48 per cent protein (mostly casein), 28 per cent carbohydrate, 17 per cent cellulose, and seven per cent ash. The high protein content is of primary importance to its use as a molding material. Protein reacts with formaldehyde and phenol to form a plastic resin which is mixed with wood flour, stearic acid, and pigments to

become a molding compound. If high moisture resistance is needed in the plastic, or if it is to be used as an insulating material, resins are produced by the simultaneous condensation of the bean protein and phenol or urea with formaldehyde in the presence of cellulose and carbohydrate. Soy bean plastics are now found in more than 20 parts of the Ford assembly (Table I), and plastics based on cotton, wood, or some other farm product bring the total number of plastic parts to nearly fifty. It is estimated that the need for material substitution will bring the total of plastic parts to over one hundred in the 1942 models. The meal is also used as a bond in making coke briquettes, as green or wet bond for foundry sand, in the manufacture of plywood, adhesives, and as paper sizing.

FIGURE 5.—A general view of the soy bean processing plant at Milan, Michigan. This plant is a unit of the Ford decentralization plan and employs eighteen local men. It is associated with another village industry which winds and assembles ignition coils. One of the trucks which transport oil and meal from Milan to the Rouge plant is to be seen between the buildings.

Soy bean oil also finds several uses in the Ford plant. This oil is of a good color and uniform quality. It is found in the enamel, both as glycerine in the glyptol resins and as an oil emulsifier of finished enamel. More than 200,000 gallons of soy bean oil a year are used in the foundry where this material is employed as a sand core bond. Other applications of oil in the Rouge plant include soft soaps, paints, and as stearic acid obtained by the hydrolosis of soy bean oil, a process which has glycerine as a by-product. About one-half gallon of this oil furnishes glycerine for shock absorbers, and another half gallon is used in combination with linseed, chinawood, castor, and Oiticicia oil in the enamel for each car. These figures represent about half of the glycerine in both enamel and shock absorbers. Five hundred thousand pounds of soy beans a year are needed to furnish the protein which is the main carrying vehicle for a water paint used in plant maintenance.

TABLE III

USES OF THE SOY BEAN IN THE FORD MOTOR COMPANY

Soy Bean Oil	*Soy Bean Meal*	*Soy Bean Stalk*
Enamels	Molded parts	Pressed board fiber
Paints	Glues and adhesives	Furfural
Varnishes	Water paint	
Linoleum and oil cloth	Core bond	
Ink	Plywood glues	
Glycerine	Briquettes	
Stearic acid	Paper sizing	
Soap		
Foundry sand core		

BEAN PRODUCTION FOR THE FORD MOTOR COMPANY

The Ford Motor Company obtains more than 90 per cent of its soy beans from independent growers living within a distance of 200 miles of Dearborn. The number of farms in southern Michigan, northern Ohio, and northern Indiana producing soy beans has increased some 300 per cent since 1932 under the stimulus of a ready market. The original practice followed by the company of loaning seed against the crop was discontinued in 1938 when 24,000 bushels were distributed. Soy beans appear to be a permanent element of land use in southeastern Michigan. Acreage in this

state nearly doubled between 1938 and 1939, and showed a six-fold increase between the 1928–1937 average and 1939. Production of beans in Michigan swelled nearly nine times during this time. Yields per acre have improved and the price per bushel has been maintained higher than the nation's average (Table II).

THE FORD FARMS

The company maintains experimental and production farms which supply about 10 per cent of the beans used in the Rouge plant (Figure 1). Four distinct land units of the Ford Motor Company are utilized for technique experiments under the direction of agricultural experts. These farms, Macon, Sharon Hollow, Belleville, and Dearborn, together include nearly 10,000 acres of cultivated land (Table IV).

The 9,700 acre Macon farm, located 52 miles from Dearborn, is the largest of the Ford farms. In addition to the 4,051 acres of crop land on this farm in 1939, it had 1,500 acres fallow, and 4,149 acres of other land, including gardens, wood lands of maple, oak, ash, and elm, and land used for the farm

TABLE IV

LAND USE OF FORD FARMS, 1939
(Acres)

Crop	*Macon*	*Sharon Hollow*	*Belleville*	*Dearborn*	*Total*
Soy beans	2,200	685	1,749	900	5,534
Wheat	1,420	...	...	240	1,660
Alfalfa	115	350	328	25	818
Corn	276	...	333	...	609
Potatoes	40	...	88	...	128
Oats	...	200	...	...	200
Clover	...	...	136	199	335
Timothy	...	...	70	140	210
Tomatoes	...	...	...	77	77
Peas	...	...	...	26	26
Totals	4,051	1,235	2,704	1,607	9,597

TABLE V[2]

PLANTING DATES, FLOWERING DATES, MATURING DATES, HEIGHT, AND YIELDS OF SOY BEANS ON FORD FARMS
1933–1935 AVERAGE

Variety	*Date Planted*	*Date Flowered*	*Date Matured*	*Height (Inches)*	*Yield (Bushels)*
Manchu	5/23	7/20	10/12	38	20.1
Illini	5/22	7/21	10/6	36	13.9 (3 year) 20.4 (2 year)
Ito San	5/22	7/21	9/23	32	20.6
Dunfield	5/22	7/3	10/5	32	7.4 (3 year) 17.4 (2 year)
Mandarin	5/22	7/23	10/1	27	17.5
Greenfield	5/22	7/22	10/11	34	25.3

[2] This table is condensed from "Soy Bean Seed Production in Michigan" by Robert A. Smith, Bull. 10, The Edison Institute of Technology, Dearborn, Michigan, April, 1936.

buildings. The 1939 production of 31,000 bushels of soy beans was below normal because the 2,200 acres of land producing beans was about 800 short of the average acreage devoted to this crop.

The Macon farm is highly mechanized because it is used as a proving ground for Ford-produced agricultural implements. Its equipment includes 80 tractors, 60 plows, 20 cultivators, 17 combines, 10 binders, a completely equipped steam saw mill and a blacksmith shop (Figure 2). Employment reaches as high as 185 men during the harvest period, and averages about 100 men throughout the year. Methods of planting and cultivation are characteristic of the area in which the farm is located. Planting takes place between May 20 and 25 when two to three pecks of either Manchu or Mandarin seeds are planted per acre (Table V). Accepted cultivation practices are followed until the harvesting combines are taken into the fields, usually about November 15, although the beans mature about a month earlier (Figure 3). Only the beans are further treated, and the foliage is left in the fields as green manure (Figure 4). A corn, wheat, soy bean rotation is used.

The other Ford farms are smaller units, but methods are essentially similar. Yields of soy beans average nearly 20 bushels per acre, about three bushels higher than the Michigan average (Table V). The national average in 1939 was 20.7 bushels, but the Michigan area is slightly poleward of optima conditions for soy bean cultivation which are found in the northern part of the Cotton Belt and in the Corn Belt. Illinois, Indiana, Iowa, and Ohio, all Corn Belt states, have approximately 62 per cent of the soy bean acreage of the United States. They produce more than 90 per cent of the total bean crop, and have the highest yields of the country.

These tests were conducted during a period when rainfall was well below normal. The 60-year average for southeastern Michigan was 17.85 inches for the period May to October; and 1933 was 24 per cent below normal; 1934 was 46 per cent below the average and the entire crop of Illini and Dunfield varieties was destroyed; 1935 was only five per cent below the average in rainfall, but an extremely early frost on October 2 reduced yields.

PROCESSING THE BEANS

Cleaning and processing of the beans is done entirely within the Ford organi-

FIGURE 6.—One of the buildings of the Milan soy bean processing plant. All Ford village industries use water power derived from small streams, and the generator intake can be seen in the central foreground of the picture.

zation. Soy beans are threshed and cleaned by air blast in the fields, and are then shipped by truck to Hayden Mill at Tecumseh, Michigan, for storage, or to processing mills at Milan, Saline, or at the Rouge plant (Figure 1). The Milan and Saline soy bean plants (Figures 5, 6, and 7) are units of the Ford decentralization plan, a project which at present includes 15 "small plants" located in rural communities within 50 miles of Dearborn. These 15 village industries emphasize the farm-factory integration by employing local workmen. The Rouge soy bean

plant also represents a typical small town installation and is completely independent of the main plant. It is much larger than either the Milan or Saline mills (Figure 8).

The processing plant separates the oil from the meal by the following process:

1. The hulls are removed by cracking.
2. Heat is applied to soften and dry the beans.
3. The beans are "flaked" (flattened) by passing them through metal rollers.
4. Flakes are subjected to a hexane solvent percolator bath which dissolves the oil from the meal. This step obtains 95 per cent of the oil.
5. The "miscella" (oil and solvent) is distilled to evaporate the solvent, which is then condensed and reused. This step has *soy bean oil* as its product.
6. The flakes, after having the oil removed, are treated with live steam, then carried to a hammer mill which grinds them into *soy bean meal*.

FIGURE 7.—Soy bean processing plant near Saline, Michigan. This plant processes soy beans from independent farms within a radius of 200 miles of Dearborn, and ships oil and meal to the Rouge plant by truck. Like the other village industries of the Ford Motor Company this plant uses a small stream for its power.

The Saline and Milan plants each have a capacity of some 435 bushels of beans a day, and yield approximately 600 gallons of oil and 20,000 pounds of meal. The capacity of the Rouge soy bean plant is nearly six times that of either the Saline or Milan mills, and brings the total daily volume of the Ford Motor Company to 3,480 bushels of beans a day, yielding some 5,400 gallons of oil and 259,000 pounds of meal.

USES OF SOY BEAN OIL AND MEAL

Soy bean oil may be used in its natural state as the oil modifier of finished enamel or as a binder for the sand cores which shape the interior of hollow castings. The most important uses of both oil and meal, however, depend on further treatment:

Oil:

1. Glycerine and stearic acid are obtained by hydrolizing the oil. Glycerine is used in shock absorbers, paints, and soap.
2. Resins used in paint are developed when phthalic anhydride, which is a product of the oxidation of naphthalene, is heated with the glycerine and stearic acid.

Meal:

1. Soy bean resin is obtained by the heating of phenol and formaldehyde with soy bean meal.
2. Molding powder is mixed from soy bean resin, wood flour, ammonia, clay, hydrated lime, nigrosene, a hardening agent, and pigment.
3. The powder is molded by compression, under heat and pressure, into a variety of plastic parts. The parts made from soy bean molding mixture are of the thermosetting type, that is they are

formed by fusing molding powder in a multiple die press under heat and pressure. Thermo-setting plastics differ from thermo-plastics which are ordinarily injected as liquid into cold dies, in that thermo-setting plastics take permanent form, and cannot be remelted and used over again.

The plastic department at the Rouge plant can mix and mold over 80,000 pounds of soy bean and cellulose powder a day. The battery of 400 compression molders in a corner of the glass plant is backed by the plastic machining units, relatively few in number because the plastic parts require little finishing. The projections which squeeze out of the mold must be broken off, and superficial polishing is necessary. Over 15,000,000 soy bean plastic parts had been molded by December, 1939.

FIGURE 8.—The Rouge soy bean processing plant is much larger than either the Milan or Saline plants. It is completely independent of the main plant and has its own power plant. Storage space for 80,000 bushels of beans is provided at this plant.

FUTURE OF SOY BEANS IN THE FORD MOTOR COMPANY

The soy bean products laboratory of the Ford Motor Company is constantly searching for greater utility for farm products. Its objective is to develop a car body on which "only the door locks and hinges" are of metal. The first of these cars was displayed in 1941. An all-plastic body of wheat, flax, cotton, hemp, slash-pine, and soy bean derivatives reduced the weight of the car by nearly 800 pounds. Mass production of the plastic body is still far in the future, although a plastic rear compartment door is expected to become standard equipment soon. This door, which weighs 25 pounds when made of steel, is only a fraction of that in plastic. It is asserted that this door is nearly dent-proof, and since the color is impregnated into the material, it is virtually scratch- and chip-proof. When the door is put on production it will add thousands of acres to the Ford Motor Company needs for farm products.

Other experiments being conducted will also augment the acreage needed to supply the company. Casein from soy beans is being experimentally used as a source of upholstery fiber. Stearic acid from soy bean oil may be used in the processing of rubber in the tire plant. Several thousand pounds of animal stearic acid are used daily in the manufacture of tires. Hub caps and other trim parts are in an experimental stage of production. The land use significance of these experiments is that each additional small part, such as the window trim, increases the needs of the Ford Company by an estimated 144,000 bushels of beans, the product of some 7,200 acres.

CONCLUSION

There are several agencies, governmental and private, experimenting with the potentialities of farm products. Increased industrial utilization of these crops is one of the methods suggested to obviate agricultural surpluses, and many crops are already accepted by manufacturers. The experience of the Ford Motor Company with soy beans

indicates that there are many ways to successfully integrate the farm and the factory. Geographic readjustments will be a corollary to the discovery of wider application of industrial chemistry, readjustments not only in our domestic agricultural economy and in the use of our non-replaceable minerals, but also in our economic and political relations with other countries.

THREE CITY PORTS OF DENMARK

W. R. Mead

AARHUS and Aalborg, the two major ports and principal urban centers of peninsular Denmark, are located upon the eastern slope of Jutland and on the shores of the Kattegat. Odense occupies the natural center of the island of Fynen. All three are ancient townships and commercial foci which have behind them generations of tradition and in their rise to leading cities of the Baltic estuary—or, as we may fittingly term it, "The Scandinavian Sea"—geographical momentum has been a force as potent as the influential combination of natural agencies. As urban settlements in a predominantly rural country and as industrial townships in an essentially agricultural economy, all provide interesting phenomena. The preëminence of the city port of Copenhagen may overshadow all other Danish ports; but the capital is firstly a Baltic port and only secondly a national center of commerce. To such merchants' harbors as Aarhus, Aalborg and Odense one must turn to discover a mirror of the commercial geography of Denmark proper (Figure 1).

In former times, the Kattegat coast of Denmark supported a profusion of ports along its indented littoral. Both physical and economic forces have led to the decay of the majority and to concentration of exchange in Aarhus, Aalborg, and Odense. Thus, the former ports of the Jutish fiords lost their accessibility with the nineteenth century revolution in shipping when dispersed trade of earlier times was narrowed down. Simultaneously, comparatively deep roadsteads off Aarhus and Aalborg and the canal at Odense conferred paramount advantages. Hence, decentralization (which has tended to assert itself in the portal structure of Finland) offers strong contrast to centralizing tendencies manifested in the Danish ports.

The rise of Aarhus as the most powerful secondary center of the state and the elevation of Odense and Aalborg to be second and third cities of the realm respectively have been coincident with the Danish economic renaissance. Their retrogression in the eighteenth century, with the decline of Denmark from a power of European magnitude to one of third class consequence, was thus transformed into a state of progress unimpeded save by the outbreak of totalitarian war. The new interpretation

FIGURE 1.—Location of the city ports of Denmark in relation to the Baltic Estuary or Scandinavian Sea. The maritime foreland has encouraged overseas contacts; while special considerations rigidly define the extent and possibilities of their respective hinterlands.

given to the value of natural resources manifested in the agrarian and commercial revolutions of the nineteenth century which transformed Denmark into an agricultural manufactory was accompanied by remarkable developments in the Danish ports. The mushroom growth of Esbjerg, springing up on the barren bluff of moraine at the head of the Grau Deep, was most spectacular. Yet, the absolute expansion of the three ports which we are about to consider was no less noteworthy and an interesting illustration of geographical selection. We shall endeavor to outline in succession the complex of natural and human forces favoring the emergence of the individual ports and historical evolution in the light of their physical background.

AARHUS

Aarhus, second port of Denmark, with a population exceeding 100,000, occupies a central position on the east coast of Jutland. The site of the port is old, as indicated by relics of Bronze and Viking Age settlement found at the mouth of the sub-glacial valley, watered by a diminutive river, which offered the original haven of refuge. This minor estuary is the focal point in the rounded bay illustrated in Figure 2. The city has grown up in the associated depression within a natural amphitheater of hills. Strategically, Aarhus has always been strong, but vulnerable. Thus, in early times, like the Baltic ports of Slesvig, it functioned as a direct crossing place on routes between Sjaelland, Scane, and Norway. After the emergence of Denmark as a national state and before an ascendant Sweden thrust a spearhead through the line of weakness defined by the Göta Alf, Aarhus extolled gain from a commanding position upon the rim of a thalassic basin ringed wholly by Danish possessions. Again, nineteenth century transformation of the maritime ante-chamber into a sea controlled by Scandinavian forces, provided a background against which the port thrived to perfection. Conversion of the Baltic estuary into a theater of hostili-

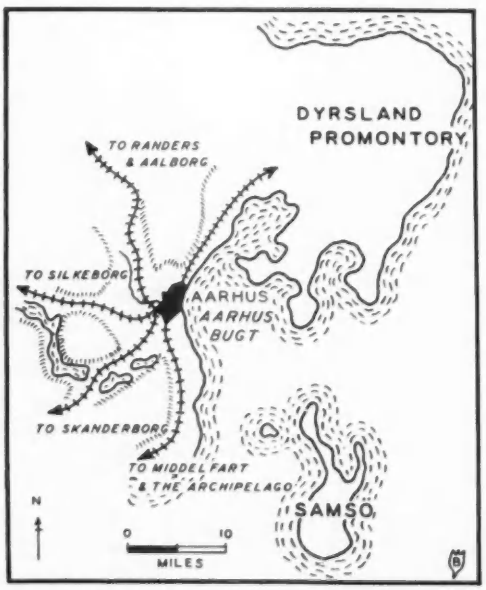

FIGURE 2.—Aarhus lies at the geographical center of Denmark, lacking that eccentricity which has become the derived attribute of Copenhagen with the shrinkage of the Danish Empire. It performs a function in Jutland similar to that played by Copenhagen in the islands. Aarhus commands the principal bay on the east coast of Jutland. Aalborg controls the principal fiord.

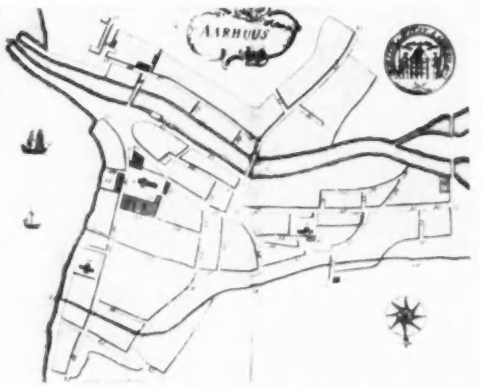

FIGURE 3.—Plan of Aarhus at the end of the seventeenth century, from Pontoppidan's "Danske Atlas" (Kobenhavn 1763–81). The river played a much greater part in the life of the port than at the present time, and trade concentrated in the Sjohavn. (Compare Figures 5 and 6.)

ties has always augured ill for Aarhus, its open position favoring peaceful intercourse and its prosperity demanding uninterrupted overseas exchange. Hence, during sixteenth and seventeenth century Swedish wars, it experienced the ill effects of geographical exposure, e.g., sack of the city in 1657, and the cumulative results of human and physical vicissitudes reduced commerce to a nullity. Aarhus felt the full effects of British blockade during the Napoleonic Wars and the marked stagnation of 1914–1918 before knowing the commercial perigee of the present time.

The outstanding feature of Aarhus is its harbor—outside Copenhagen the most important in Denmark. As with Esbjerg, it is an artificial creation and principally the product of the last century. From Figures 3 and 4, which give an early eighteenth century impression of the city plan, we can form some idea of its original outlines. Bulwarks and moles alongside the river with its six foot anchorage, dated from the Middle Ages. Accessibility was the keynote of medieval and renaissance Aarhus. With the eighteenth century rehabilitation of the city, attention was

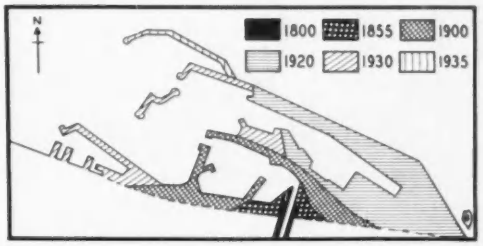

FIGURE 5.—Expansion of Aarhus harbor, after a diagram in the Maritime Section of the Museum at Elsinore Castle. (Not to scale.) Aarhus harbor continues to thrust its tentacles out farther into the bay. Its quayage already approaches nine miles and embraces a water area well in excess of 100 hectares. A "Seven Year Plan" for expansion and amelioration of the harbor works had been commissioned shortly before the outbreak of hostilities. (Development has been fully treated by Emmanuel Sejr, "Traek of Aarhus Havns Historie," Aarhus, 1937.)

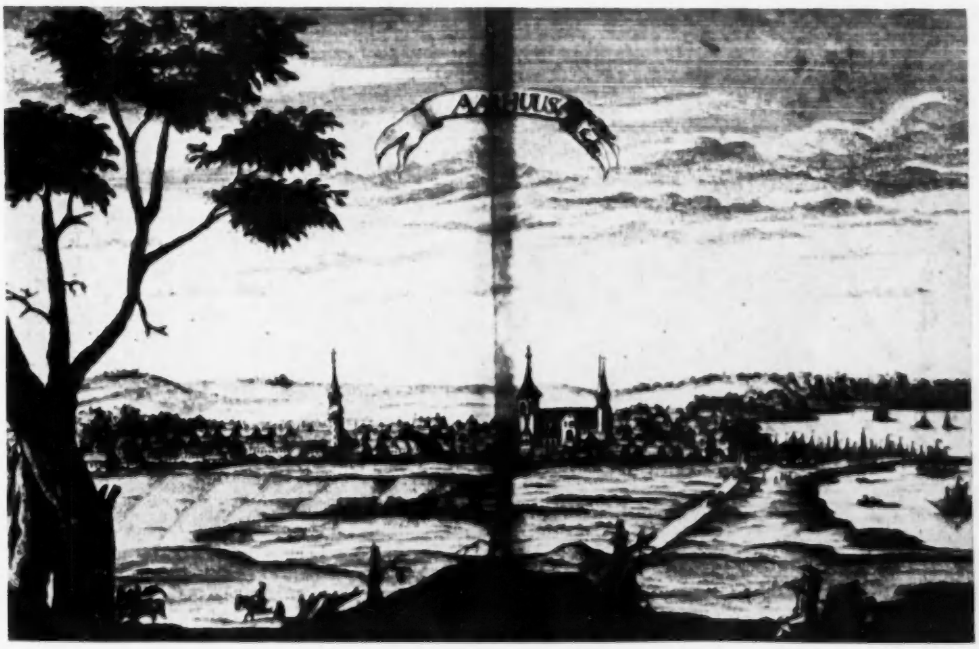

FIGURE 4.—Perspective of Aarhus from Pontoppidan's Atlas. Aarhus persists as an ecclesiastical and cultural center, its cathedral remaining the largest in Scandinavia. The wooded hills of the Risskov in the background and Marselisborg in the foreground define the limits of the present urban area.

focused upon the deficiencies of the harbor. The only alternative to active reconstruction of the latter feature was unenviable decay. Hence, in 1735, the Søhaven was begun—a distinct feature from the "Kanal" which had formerly served as the haven. (See Figures 5 and 6.) Financial stringency made deepening a slow process independent of the fact that the harbor as it pushed into the open sea, encountered great technical difficulties. Yet, since the mid-nineteenth century when the impact of the industrial and commercial revolutions struck Denmark, harbor works have not ceased to expand in response to trading demands.

Modern Aarhus dates from the 1860's. The classical Danish geographer and chorologist, Eric Pontoppidan, in his exhaustive Danske Atlas eller Konge Riget Dannemark"—1763–81, described the related province of Aarhus as being, without exception, the most fertile and densely populated of the administrative divisions of Jutland. Small wonder that, after the temporary interruption of the Prussian War of 1864, when steamship and railway entered into the picture, a wave of prosperity began for the city. From a town of 11,000 inhabitants in 1860 Aarhus grew to a city with 25,000 population in 1880 and 50,000 in 1900. The railway did much to stimulate this growth. Jutland's first railway linked Aarhus to Randers (1862). Space prevents detailed consideration of the historical evolution of Aarhus (which is dealt with comprehensively by Jens Clausen in his book "Aarhus gennem Tiderne." Kjøbenhavn, 1939). Nevertheless, we may trace the interplay of three main forces in the coincident development of its all-important trade.

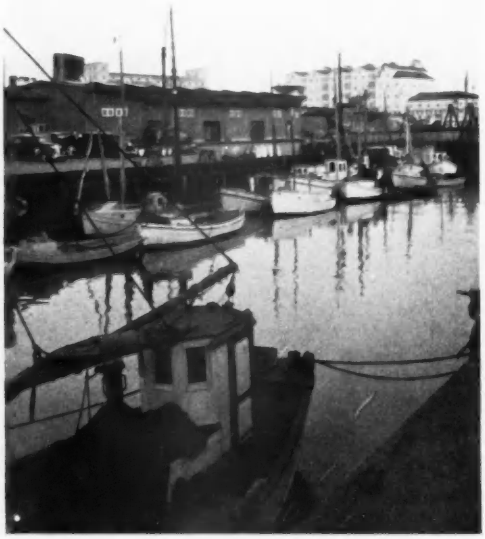

FIGURE 6.—Sjøhavn as it appears today. In the background may be seen corn and fodder silos which have grown up on the inner moles of the harbor works.

There is first the forceful agency of the agricultural hinterland with its output and demands. Exports from agricultural sources constitute only a fraction of Aarhus' exports (for the flow of agricultural exports has been essentially westward). Fodderstuffs, however, constitute the third largest group of imports under normal circumstances when Aarhus serves practically half of Jutland with these commodities. Oil cake has been the principal fodder material entering the port. Under "Grains and pulses" are included tropical products which partly serve requirements of the farming community and partly satisfy needs of industrial Aarhus. The second agency is the manufacturing industry of the city and its environs. Industrial emphasis has always been upon specialized high quality commodities, production has been based upon imported raw materials, consumption principally by the home market. Aarhus has played a pioneer rôle in the development of the Danish margarine industry. The

first factory was opened in the city (in face of much opposition) in 1883. Today the highly evolved manufacturing process built upon vegetable oils provides a variety of by-products for the farming community. Demands of the urban area itself are the bases of the third force. Here, importation of commodities for consumption and conversion is supplemented by importation for production of kinetic energy. In a country with an absolute deficiency of coal, it is hardly surprising that this is the chief product entering the harbor in so far as bulk is concerned. Naturally, the most cursory glance at the structure of trade betrays indulgence where imports are concerned and a markedly adverse balance as the essential characteristics.

FIGURE 7.—The little river at the mouth of which Aarhus was born has declined progressively in importance over the last century. No longer is it an asset in the life of the city. Its conversion into a subterranean channel is typical of changes in the cultural landscape of the city center.

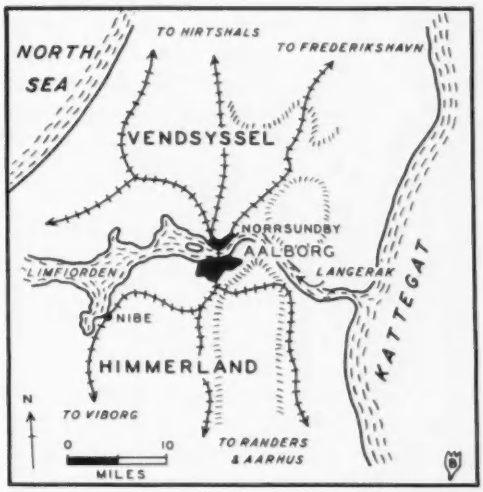

FIGURE 8.—Aalborg and the North Jutland crossroads. Notice the interrelationship of landward routes and Limfiorden.

INTERRELATIONSHIP BETWEEN AARHUS AND AALBORG

The relationship between Aalborg and Aarhus is naturally competitive. Both are collecting and distributing centers for a wide area. Because Denmark is a small state and natural resources are largely similar throughout the length and breadth of the constituent parts, there can be no symbiotic relationship of consequence between the ports. They are competitive for a common hinterland—in all the varied meanings of that term. The closely fretted network of Danish roads, together with a railway system of intricate pattern (and almost extravagant length) has produced a certain overlap in the orbits of influence of the two centers; although Aalborg, with its northern suburb of Norrsundby, claims Vendsyssel island, while Aarhus extends the sphere of its attraction southwards towards the Schleswig isthmus. The rivalries of the two ports are played out upon the broader girth of the Jutish peninsula, with Viborg feeling the interplay of both. In so far as there is suggestion of economic polarity in their

production, it is derived from specialized industry based principally upon imported raw materials. Comparisons between Aarhus and Aalborg we shall treat below.

AARHUS AND COPENHAGEN

It is interesting to compare the position of Aarhus with that of Copenhagen and the relationship between them. While Aarhus lies at the geographical center of gravity of modern Denmark, Copenhagen is located at the commercial center of gravity of the Baltic region. Since early times, Denmark, in control of the Oresund, has set its seal upon the lips of the Baltic Sea; and Copenhagen, poised between a hintersee with high commercial intensity and the World Ocean, has controlled and benefited from the movements of a preponderant part of North European commerce. As a result, the Danish metropolis has specialized in international trade to an infinitely greater degree than Aarhus which, lying just off the current of Baltic trade and being responsive to a vital national hinterland, has conducted an essentially intra-national trade. Copenhagen, as the magnitude of its free harbor reveals, thrives as an intermediary. (It is largely due to this fact that the capital of the smallest Scandinavian state is the largest city in Northern Europe.) Aarhus has only a very small entrepôt trade with other countries. Contrastingly, from a nationally strategic standpoint, the location of the capital is weak while that of Aarhus is strong. Aarhus derived its concentric location in

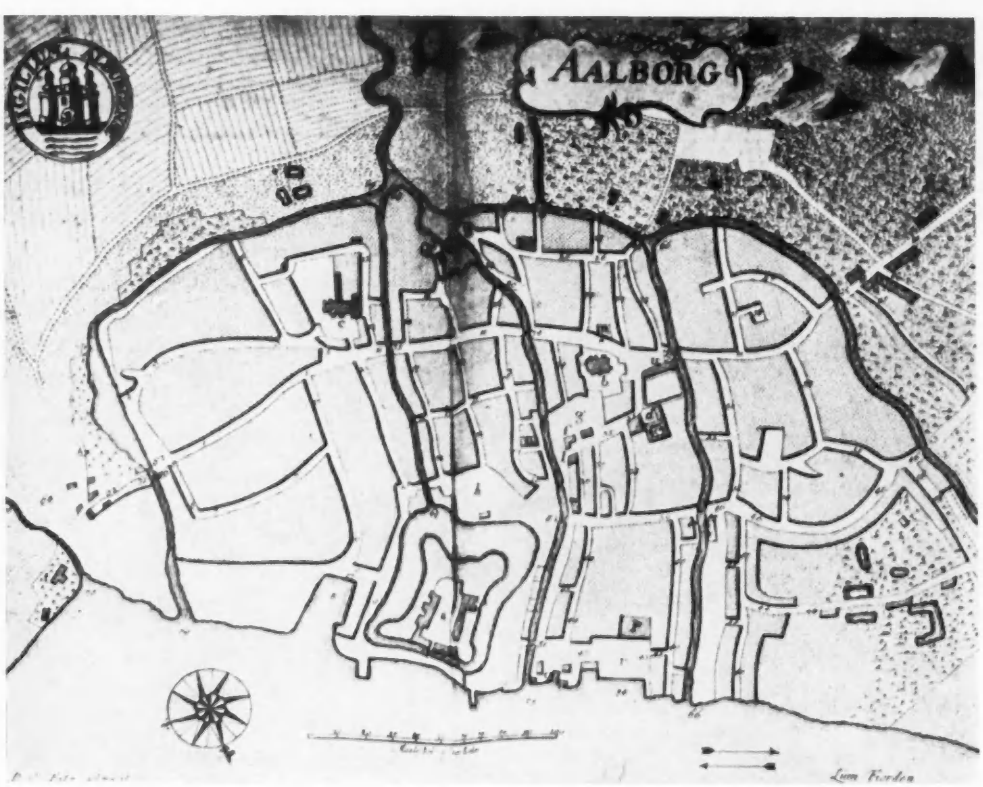

FIGURE 9.—Plan of eighteenth century Aalborg from Pontoppidan's Atlas. At the center of the map is the fortress which became an indispensable appurtenance of the port during the age of piracy. The striking mesopotamian characteristics of the city plan are its most outstanding features.

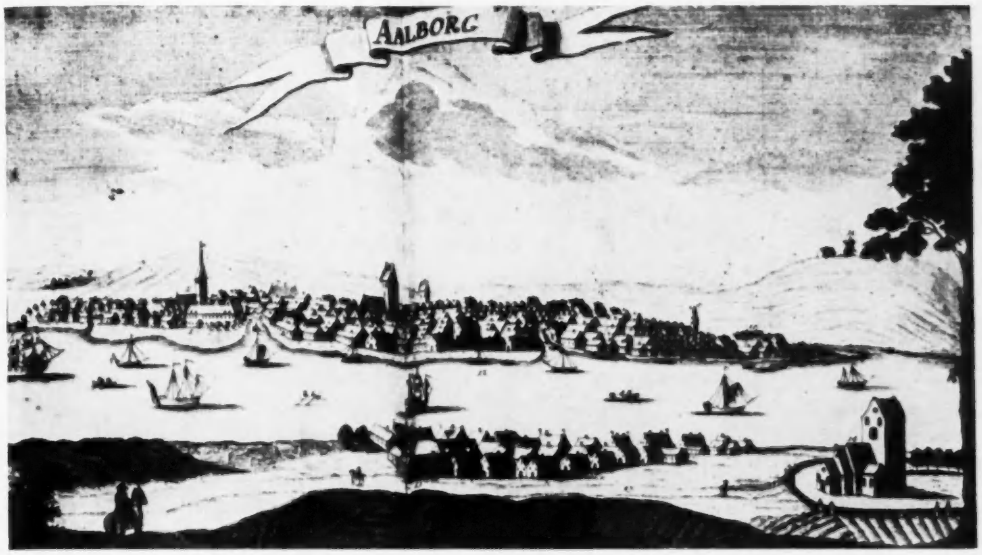

FIGURE 10.—Profile of Aalborg from the northern bank of Limfiorden (Pontoppidan). The encircling rim of hills is clearly manifested. Figure 11 was taken from an elevator which occupies the site formerly held by the mill to the right of the illustration.

relation to the delineation of national frontiers when Copenhagen became excentric with the loss of Swedish possessions in the seventeenth century. Hence, while Aarhus enjoys a nationally strategic position, Copenhagen occupies an internationally strategic situation. Locational strength, however, like the security of Denmark, rests upon maintenance of political equilibrium in the wider European concert.

Liaison between the focal city of peninsular Denmark and the island capital is strong. Aarhus is regionally independent of, but politically subordinate and economically responsive to Copenhagen. As evidence of this we may cite that Aarhus conducts more trade with the metropolis than with any other port. Almost the entire trade between the two commercial cities is conducted over maritime routes. Under normal circumstances, passenger, as well as cargo traffic on the Copenhagen-Aarhus route is intensive. Alternatively, the link between Aarhus and Kalundborg serves to connect the regional metropolis with Sjaelland. Rail communications, even for passenger traffic, are less favored. Moreover, because the commercial prosperity of the capital is ultimately a reflection of the general intensity and liberty of exchange over the Baltic hinterland, we may infer that Aarhus is indirectly affected by the wider exchange conditions in the geographical province of Baltoscandia. Aarhus cannot aspire to emulate Copenhagen as an international center; but as capital of Jutland, it can lay claim to the title of the Copenhagen of peninsular Denmark. (For a full story of the rise of the city, probably the most comprehensive book is "Aarhus: Byens Historie og Udvikling." Kjøbenhavn. MCMV.)

AALBORG

Situated at a junction of road and water routes which forms a major Cimbrian crossroads, Aalborg has always occupied a commanding location in northern Jutland. It lies upon a constriction of Limfiorden at the head of the broad and accessible eastern arm. To

FIGURE 11.—Panorama of modern Aalborg. Two principal features assert themselves: (1) the intersection of arterial land and water routes, and (2) the latitudinal expansion of the city along Limfiorden and industrial concentration upon the waterfront.

the west, Limfiorden expands into a succession of shallow broads which, in some features, recall the lakes in the hinterland of Aarhus. The port, approached by the negotiable channel of Denmark's most deeply penetrating fiord, is therefore oriented to the Kattegat. East-west flow of water-borne trade has dwindled both as a consequence of changing physical circumstances, e.g., silting up of Thyboren (North Sea outlet of Limfiorden) and as a result of commercial revolution which has converted Aalborg into a terminal exchange point. Movement along the great north-south artery which spans Limfiorden has increased simultaneously. From a ferry port controlling the bulk of traffic over a principal Jutish routeway, Aalborg was converted into a bridge town in 1865. While Aalborg, on the southern or mainland shore of Limfiorden, is focus of routes from the level agricultural lands and wolds of Himmerland, Norrsundby—the suburb across the channel—subtends virtually the entire agricultural region of Vendsyssel which lies within the scalloped arc of North Sea duneland. Evolution of the railway network and the growth of road transport have intensified convergence of routeways upon this point of assembly. (See Figures 8 and 11.)

As a commercial center, Aalborg is equivalent to an up-river port, enjoying great economies in dealing with its ostensibly circular hinterland and comparing, in this respect, with Odense. It has the open quays and docks of a sheltered non-tidal port and extensive natural harborage (thus contrasting with Aarhus and Odense). Deepening has been a relatively simple process, so that vessels exceeding 10,000 tons now have access. Naturally, the site has attendant disadvantages. Langerak, for instance, is natural drainage basin for not inconsiderable stretches of northern Jutland. Its sluggish currents and general resemblance to a fresh water estuary make for occasional winter embarrassment by ice. Commercially, Aalborg is less influenced by the domination of Copenhagen, both distance from the metropolis and character of activities accounting for this independence. Unlike Aarhus, which has always had intimate economic relations with the islands, Aalborg has conducted itself largely independent of the Danish archipelago.

Since pagan times, traffic has flowed through Aalborg. Cimbrian peoples concentrated upon the site which was the focus of historic trackways at the apogee of Bronze Age culture. (The Cimbric bull which stands in the principal thoroughfare of modern Aalborg recalls the industry of the watermeadows which employed the attentions of these

early settlers.) Like embryonic Aarhus, Aalborg also became caught in the web of Frisian trade—500–900 A.D. (The subject is treated authoritatively in "Friserna och Forntids Handelsvägor i Norden," Elis Wadstein. Göteborgs Vetenskaps och Vittenhets Samhälles Handlinger. 1918–1919). Viking traffic, coursing through the throat of then navigable Thyboren, sought protection of the sheltered marine ante-chamber of Limfiorden before joining the main-stream of trade which flowed southward over the so-called "Västrvegr" to the Mediterranean Sea.

The initial settlement of Aalborg (or Alebur, "the town of the flooded meadows," as it was first known) occupied a mesopotamian location flanking the Limfiord channel where it is at once narrowest and deepest. The intercepting system of waterways which threaded the mediaeval town and which, in conjunction with a stockade, formed additional protection for the settlement, retained their identity down to the seventeenth century as can be seen from Figures 9 and 10. Thus, even after the decline of the Danish Empire, the minor estuaries of these streams, tributary to the eastern arm of Limfiorden, offered harborage for merchantmen. At the height of the Renaissance, trade concentrated along the Osteraa from Bispensgade to Gammaltorv; while the site of Jens Bangs celebrated Stone House, marks the disposition of the early wharves (Figure 13).

Economic importance of the city has changed with successive generations. Proximity to Norway (as Denmark's northernmost port) accounted for much at the time of the Union, and Aalborg still rivals Copenhagen as leading port for Denmark's polar empire. Herring fisheries which were a primary source of wealth to Gothenburgers were also exploited to the full by Aalborg fishermen and were a principal item of trade down to the nineteenth century. (See interesting observations by E. D. Clarke "Travels in Scandinavia." London 1838.) Fisheries are now of subsidiary importance. A prosperous industry has been fostered in the last fifty years.

The major industry of Aalborg is explicit in the city's panorama (Figure 11). The modern industrial era was heralded by the foundation of the first cement works in 1893—in much the same way as the vegetable oil factory in Aarhus marked a turning point in

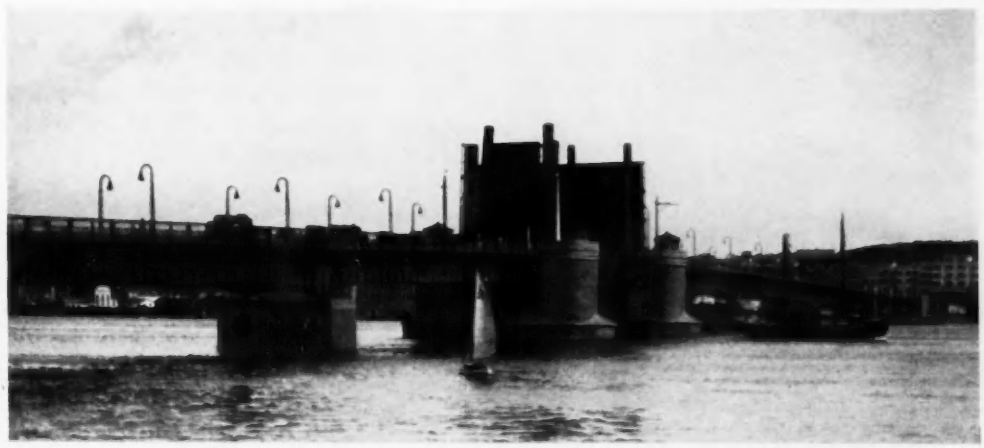

FIGURE 12.—A pontoon bridge succeeded Aalborg ferry in 1865. This, in turn, yielded to the present cantilever structure and its supplementary railway bridge. Nodality of Aalborg has been intensified by this vital link, which is the focus of main routeways of northern Jutland.

economic life. Aalborg has five great cement producing factories. Physical basis of this industry is found in coincidence of extensive chalk deposits (Figure 14), glacial and post glacial (Yoldia) sands and clays. It was lamented by Pontoppidan in "Thy chalk is found; but on account of lack of fuel it cannot be burnt except at great cost." Now, cheap water transport has facilitated import of coal from British mines and, thereby, production and export of cement and allied products. (In point of fact, the same complex of economic and physical circumstances may be seen operating in Thames estuary cement manufacturing plants under normal circumstances.) Superphosphate industries occupy a leading position and reflect the importance of artificial fertilizer in a country of intensive agriculture. This aspect of Aalborg's industry rather invites comparison with synthetic nitrate production in Norwegian electro chemical industries. Large-scale production of spirits and beer represents development of an old-established industry—malt was a leading import in the eighteenth century. As with Aarhus, Aalborg has been a printing and publishing center for at least three centuries. This is but one aspect of the existence of the cities as cultural foci.

FIGURE 14.—Low chalk wolds which surround Aalborg offer the source of raw materials for the principal industry of the vicinity—cement manufacture.

FIGURE 13.—Jens Bang's Stenhus. A typical expression of the imposing headquarters of renaissance merchant princes in Denmark at the high-water mark of seventeenth century commercial life.

The cultural landscape and atmosphere of Aalborg contrasts with that of Aarhus. This is partly attributable to local geographical conditions; partly to the human element. Aalborg is a much more lively organism than Aarhus. Modernity is its keynote. Aarhus has an atmosphere of established trade and secure connections with its predominance resting upon tradition. In Aalborg, there is felt a conscious striving to raise commercial intensity to a higher pitch. Although a progressive regional center, Aalborg has never caught up the time lag in its economic development which gave Aarhus the lead in the mid-nineteenth century. The remarkable growth of the last two decades has been blighted by present political circumstance; but in any future state of

FIGURE 15.—Odense Ship Canal. Some ten miles of canal bring the port into direct contact with Odensefiord, preventing the stagnation which has befallen other ports occupying a location so retired from the coast.

established relations, geographical forces offer assurance that the economic barometer for Aalborg is set fair.

ODENSE

If Sjaelland is the matrix, Fynen may be called the hub of the Danish world, and Odense, fourth port of the kingdom, occupies the natural focus of the island. Odense traces its origin back well over a thousand years. Acting for a short while as governmental center, its present importance is derived from commercial, communicational, and ecclesiastical factors. The 100,000 population which resides in the urban area coming under the administration of the city represents nearly a quarter of the population of Fynen and finds livelihood in industries directly connected with the natural resources of the island.

The port is not situated directly on the fiord coast; but is located on the Odense Aa, some ten miles inland (Figure 20). Like Ribe, in southern Jutland, this retreat from the coast gave to the city protection from attacks which more exposed towns like Aarhus were suffered to experience in the days of piracy. Unlike Ribe, however, Odense

FIGURE 16.—Perspective of Odense (Otthoniae) in 1593 from Braun and Hohenbergius's "Civitates Orbis Terrarum," 1573–1618. . . . *Sita aute est loco amoenissimo et fertilissimo, pratis, agris et piscosis rivis abundanter cincta*, runs the accompanying inscription to this garden city in the garden of Denmark.

was alive to forces making for decay in a port not directly in contact with the sea. At the end of the eighteenth century, the Merchant's Guild of Odense petitioned government for a canal to link the city with Odense fiord. Despite national difficulties caused by the Napoleonic Wars, this was constructed during the decade following 1794 and purchased by the people of Odense in 1858. Rising trade prompted extensions and improvements to associated docks and the perspicacity of the Odensers has been rewarded. At the present time, a channel 25 feet in depth is accessible for vessels of several thousands of tons. The canal does not penetrate to the center of the town so that, as in Esbjerg, harbor and docks are somewhat divorced from the rest of the urban area (Figure 15).

The morphology of the island of Fynen has played an influential rôle in the rise of Odense. (For detailed information the reader may refer to Elizabeth Weymann-Munck's treatise "Fünen als Siedlungsraum": Berliner Geographische Arbeiten. 1936. Heft 10). The city lies in the natural center of the island surrounded (except on its seaward side) by gently rising land which culminates in a girdle of morainic hills. Central situation made for natural gravitation of the economic life of Fynen to the city, once it had assumed precedence over possible rivals. Odense therefore became nodal point in the transport routes of Fynen during the Middle Ages and traffic converging upon it has not ceased to grow. Hence, the greater part of the island now lies within the economic and commercial regime of Odense, the aureole of glacial hillocks defining the approximate outlines of the hinterland. Level topography has assisted construction of arterial roads (Figure 18), so that modern transport ways, radiating from the urban center have superseded the old trackways which threaded together Fynen's ancient settlements. As a result, Odense, despite its adoption of other functions, is first and foremost a market and distributive center.

FIGURE 17.—Sugar beet is a principal crop of Fynen in the hinterland of Odense.

The marketing function assumes large proportions because Fynen is the acknowledged "Garden of Denmark."

There is, in Braun and Hohenbergius' magnificent baroque Atlas, a delightful prospect of Odense—Ottonia—at the time of the Renaissance (Figure 16). Four distinct zones of land utilization are distinguishable. Within the confines of the city area, but on the fringe of the compact and densely settled urban nucleus, is an intensively tilled fruit and vegetable zone. Concentrically, there appear croplands (devoted to cereals), a zone of cattle pastures and woodlands and, finally, sheepwalks on

the surrounding hills. "I must confess to you that I am charmed with the Isle of Funen, whose soil is good: all sorts of grain grow here to perfection: the fruit is exceedingly good and the landskip very agreeable, the country being up and down intermixed with fine woods, delicate meadows and gentlemen's houses" wrote the English Envoy in his journal in 1702 (published in London, 1703).

Today, the city has spread out over the orchards and vegetable plots which graced the town's prospect with such pleasing formality. Yet the same essential characteristics are manifested in its modern panorama. Production of garden crops, for instance, in the neighborhood of Odense is second only to that in the environs of Copenhagen. Canning of fruits and vegetables, a response to the horticultural emphasis, and a steadily growing export of conserved produce were features of the activity of pre-war Odense. Cereal production has declined since the eighteenth century; but cattle raising has assumed greatly increased proportions. Odense handles the greater part of the milk production of the Island. It possesses also the largest bacon factory in Denmark and one of the finest in the world. This, together with its branch at Assens (in S. W. Fynen), has capacity to deal with half a million pigs annually. It is interesting to note that Pontoppidan, in his eighteenth century *magnum opus* referred to above, classified sugar refining as a leading industry of the port. Odense's large modern refineries are a typical expression of this part of the Scandinavian countryside. In Scane, the corresponding "Garden of Sweden," there are, for example, similarly large central establishments, e.g., at Arlöv. Beet has been intensively tilled on the richer and moister clay soils of the Danish islands, where summer maximum of precipitation is combined with higher average temperatures than on the peninsular mainland (Figure 17). Fynen's production plays an important part in rendering Denmark

FIGURE 18.—Fynen, from the top of an elevator upon the outskirts of Odense. The arterial road in the foreground is the direct route to the Little Belt Bridge. The morainic plain rises gently to the amphitheater of end moraine hills in the distance. The landscape is typical of the hinterland of Odense.

FIGURE 19.—The Little Belt Bridge. This is the main link between Fynen and the mainland of Jutland.

self-supporting in respect of its sugar supply. Sugar refining in Odense is a seasonal operation, activity reaching its highest pitch in autumn months following the harvest. The relationship of beet and sugar refining industries to dairying and canning is obvious.

Odense, besides being unrivalled market for the produce of Fynen and an important center of conversion and export of agricultural products, is also a source of supply. Summarizing the structure of its trade from the last table of figures available before the outbreak of war (Odense Byraads Førhandlingar), we find imports graded in the following categories and declining in the same order: Coal and coke, corn products, fodderstuffs, metals, stone and clays, timber. Shipyards along Odense Canal consume the greater part of the coal import; though such secondary industries as bicycle and canning must be remembered. As with other leading Danish ports, imports are in excess of exports. The balance is even more unfavorable than at Aalborg and Aarhus —imports accounting for 87 per cent and exports for 13 per cent of the total.

Hitherto regular and frequent steamship services were maintained between Odense and Antwerp, Newcastle, Leith, Liverpool, and with the home ports of Copenhagen, Aarhus, and Samsø. Regular connections with Hamburg, Bremen, Stettin, and Lubeck (dealing principally with cattle) recalled medieval contacts: periodical communications with Danzig and Amsterdam linked Odense with other Hanseatic entrepôts. Traffic was most intensive during the summer months, for, apart from the seasonal demands of many of the ports' industries, ice occasionally renders approach difficult of negotiation.

The economic significance of Odense cannot be considered independent of its strategic position in relation to the geographical outlines of Denmark. Fynen, lying midway between Jutland and Sjaelland, is a vital stepping stone between the capital and the North Sea coast. The Little Belt Bridge has united Fynen to the root of Jutland, to which territory the island seems legitimately to belong. Ferries ply continuously between Nyborg and Vordingborg, spanning the Great Belt. Odense being intermediate between the Great and Little Belts has experienced varying influences as a result of the changing conditions of communications on the east-west route. Lying halfway between Copenhagen and Esbjerg, athwart the main communicative axis of Denmark, Odense has mixed prospects. The major routeway between the metropolis and the west coast has brought much additional traffic to Odense. The fact that the established railway lines also converge upon the city, together with improvements in rail transport and cheaper freights, have given it a new importance as a route center. For example, with restoration of European equilibrium, a growing percentage of the trade of Odense must tend to move via Esbjerg. Export of agricultural produce, in particular, has responded to improved communications with the west; while more perishable consumption goods

will probably use this route increasingly as an alternative to slower sea transport.

While many forces have exaggerated the importance of Odense as a nodal point in this transverse routeway, we must not overlook certain factors which have operated simultaneously to diminish its significance. Passenger traffic, for example, between Esbjerg and the capital tends to pass by Odense. Although it gains consequence as a strategic point in national routeways, Odense therefore tends to decline relatively in the system of international communications. Thus, fast traffic between Germany and the major Scandinavian peninsula passes by Odense. The old land route from the German cities by way of Holstein and Fynen to Sjaelland has, in fact, been largely superseded by the Warnemunde-Gedsjer ferry; while Esbjerg had hitherto a daily air service with the capital. As distinct from rail communications, road traffic between Fynen and the mainland has been greatly facilitated by the Little Belt Bridge (Figure 19). Odense has responded to the impulse by improving its arterial connections with Middelfart and Nyborg. The "Via Occidentalis" which we see in Figure 16 has attained the zenith of its importance in recent years.

The town itself lacks the animation of Aalborg and suggests rather the atmosphere of established trade which is apparent in Aarhus. Yet, it is an urban expression of Fynen. Being in intimate contact with a well defined hinterland, its changing structure has reflected the fortunes of the islanders. Odense still functions as heart and brain in the anatomy of the island. Both in its relationship to Denmark as a whole, however, and to adjacent states, Fynen occupies a new position and Odense has experienced most fully the accompanying changes, reacted to them and transmitted them to its rural back country. The pulse of the city beats faster, the stream of traffic courses more rapidly through its arteries as Odense has felt outside influences slowly overwhelming the internal forces which have for so long been dominant in its physiology.

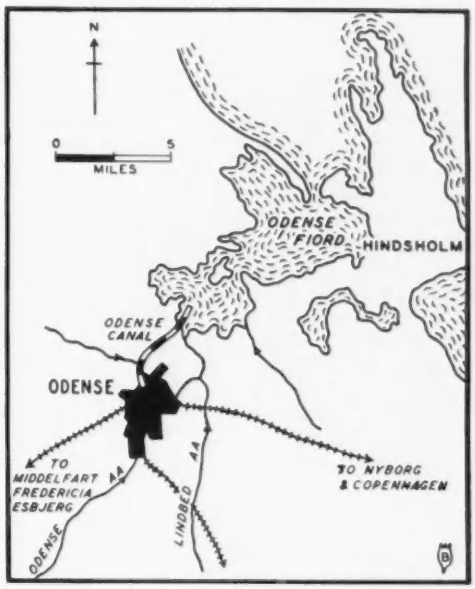

FIGURE 20.—Site of Odense in relation to its fiord and associated waterways.

CITY PORTS IN BLOCKADED EUROPE

Experience of past wars offers some indication of the general effects which have been mirrored in the city ports of Denmark following upon the inclusion of the country in the closed economic system of blockaded Europe. In the final place, their prosperity is a reflection of exchange relations set in motion by a highly evolved and progressive agriculture. This, in turn, presupposes an unrestrained flow of trade. Now that the European war has severed the slender life lines of Danish overseas exchange with an outer world which provided sources of supply for its agricultural manufactory, the national economy has had to adapt itself from a

universal to an almost medieval sphere of exchange. For, in the reinterpretation of geographical relationships which has accompanied the change from peace to war, the sea has reverted from its modern function as a link to its past function as a barrier. Nowhere, in Europe is this more true than in the case of the narrow seas which encircle Denmark. Whereas the city ports have hitherto turned their faces to the sea, they now turn their backs. They will have experienced most fully effects of the process of attrition, being intermediaries between the two most important elements of Danish society—the farmer and the sailor. As exchange points of a specialist country transposed to an environment where specialization is frustrated they offer just one instance of the problems of urban adjustment which confront city ports of occupied Europe.

CONCLUSION

Aarhus, Aalborg, and Odense, this trinity of cities, will remain the keystones of provincial Denmark. In each case, we can discern the force of a progressive and normally prosperous agricultural back country as a staple of the ports, with industry as a kindred activity springing out of the same soil. In each, we can trace the accumulation of centuries of wealth and tradition—the persistent force of geographical inertia. In each, we have clear evidence of the impulse which Sir Halford Mackinder would consider animates the "going concern," the procreative agency of geographical momentum. Weaknesses of the economic geography of Denmark are reflected in the structure of Aarhus, Aalborg, and Odense as economic phenomena and exaggerated at such times of adversity as the present. Limitation in the variety of indigenous resources has expressed itself in the form of their trade and in the make-up of their industry. Broader conclusions can also be drawn from the study of these city ports. From them, we can see how topographical forces decline in importance as an urban center evolves and expands about its original nucleus; while locational factors assume an augmented importance. Moreover, relating their evolution to the broader canvas of the Scandinavian region, we can find in their history a sympathetic response to the intermittent expansion and contraction of the North European political system and to the transformation which has taken place in the status—economic and political—of the Danish kingdom.

LANDSCAPE TYPES ALONG THE NUEVO LAREDO-MEXICO CITY HIGHWAY

George F. Deasy

THERE is at present but one hard-surfaced, all-weather road leading from the United States into Mexico—the one via Laredo, Texas. This highway extends southward from Nuevo Laredo for a distance of some 765 miles to Mexico City, passing on the way through a considerable variety of landscape patterns. This article is an attempt to delimit and characterize the major landscape types that are encountered by the traveler on his journey southward over this road. It is based upon several reconnaissance trips made by the author over that section of the Pan-American Highway.

Figures 1 and 2 are, respectively, a map and a profile of the highway. The map shows the relation of the road to the dissected edge of the Mexican Plateau (the most important topographic feature of that section of the country through which it extends), and the location of the cities, towns, and villages along the road. The profile presents the varying elevations of the highway.

The initial stage in a trip southward from Nuevo Laredo finds one in a setting characterized by topographic youth, aridity, a sub-tropical temperature regime, and desert-like vegetation (Figure 3-A). Rural population is sparse, and towns and villages are infrequent. Crop land, in most places, is almost totally lacking, and agriculture, where practised, is of necessity the dry-farming or irrigation type (the latter being based upon water from the edge of the Plateau to the west). The crop and domestic animals that occasionally catch the eye of the traveler are corn, sheep, and goats. The typical rural dwelling in this region of little vegetation is, significantly, the adobe hut. This unique complex of natural and human elements may be said to constitute Landscape Type No. I along the Mexico City Highway (Figure 3-B).

The first noteworthy change in surroundings on the way south appears close to Sabinas Hidalgo. At this point the previously level topography of the Coastal Plain gives way to a series of alternate stretches of flat to rolling Piedmont and rugged Plateau spurs.

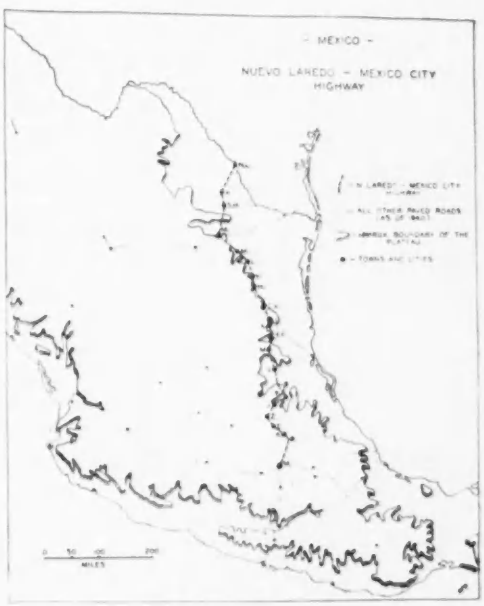

FIGURE 1.—The capital letters on both the map and the cross-section (Figures 1 and 2) represent the names of the various major towns and villages along the Nuevo Laredo-Mexico City Highway, as follows: N.L.—Nuevo Laredo; V.—Vallecillo; S.H.—Sabinas Hidalgo; M.—Monterey; M.—Montemorelos; L.—Linares; V.—Villagran; H.—Hidalgo; C.V.—Ciudad Victoria; L.—Llera; V.J.—Villa Juarez (Mante); M.—Morelos; V.—Valles; T.—Tamazunchale; J.—Jacala; Z.—Zimapan; I.—Ixmiquilpan; A.—Actopan; M.—Mexico City.

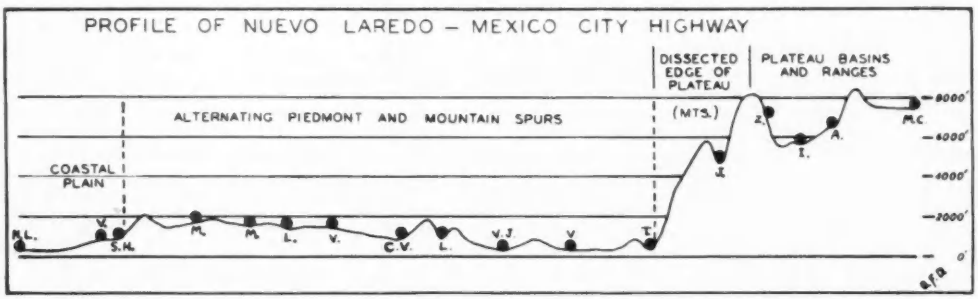

FIGURE 2.—The four major physiographic regions traversed by the Nuevo Laredo-Mexico City Highway are delimited in the above profile of the road. Letters represent the names of the major towns and cities encountered along the highway, as described below Figure 1. Vertical exaggeration of the profile is approximately 88.

This change, however, is not sufficiently important to warrant the classification of this segment of the road, south of Sabinas Hidalgo, as a separate landscape type, because of the unbroken continuity of the other elements (both natural and human) of the environment.

After passing Monterey several significant changes occur. Rainfall becomes appreciably greater; vegetation is correspondingly less parsimonious, with scattered low acacia trees and tall cacti appearing. Crop land becomes proportionally more important, although still occupying only a small percentage of the total land area. Corn and wheat are more obvious items in the surroundings, and the culture of oranges and other sub-tropical crops begins. Because of the greater availability of building materials from vegetational sources, brush huts tend to supplement or replace the former adobe huts (Figure 4). Hence, despite the fact that certain other natural and human items continue essentially unchanged (topography, types of farming, etc.), the region south of Monterey is more than sufficiently different from the segment to the north to merit classification as Landscape Type No. II.

Important modifications of the surroundings again may be noted south of Ciudad Victoria. The rainfall has increased from semi-arid to sub-humid proportions; temperatures become truly tropical rather than sub-tropical. The scattered acacias are replaced by low forests of trees of similar type and, where ground water is plentiful, by dense forests of tall palmettos (Figure 5). Because of increased precipitation, farming is a combination of irrigation and humid agriculture (depending upon the crop) rather than the previous association of irrigation and dry farming. Corn remains a prominent crop, but the wheat and sheep so characteristic of the semi-arid region farther north give way to sugar cane and cattle. The physical environment, however, remains one of alternating segments of Piedmont and Plateau spurs, while rural population still continues sparse and villages are widely spaced. These similarities to regions farther north are insufficient to prevent the designation of this Ciudad Victoria-Tamazunchale section as Landscape Type No. III.

A short distance before Tamazunchale is reached, highly significant changes in the natural and cultural setting begin to occur. It is at this point that the rugged dissected margin of the Plateau is first encountered. (The edge of the Plateau, however, is almost constantly visible to the west from the highway as it parallels the road between Monterey and Tamazunchale.) Relief and elevation increase, and with this comes an

increase in rainfall, so that humid conditions prevail. In the section north of (below) Jacala, however, the increase in elevation is insufficient to lower temperatures appreciably, and tropical temperature conditions continue. A dense, low tropical forest, with the accompanying ferns, vines, and epiphytes, constitutes the vegetative response to these conditions (Figure 6-A). Man also reacts to this new climatic environment. Crop land increases. Humid-type agriculture completely replaces irrigation farming. While corn and cattle remain very important, the banana and the coffee tree supplant sugar cane as conspicuous crops (Figure 6-B). Rural population increases in density in re-

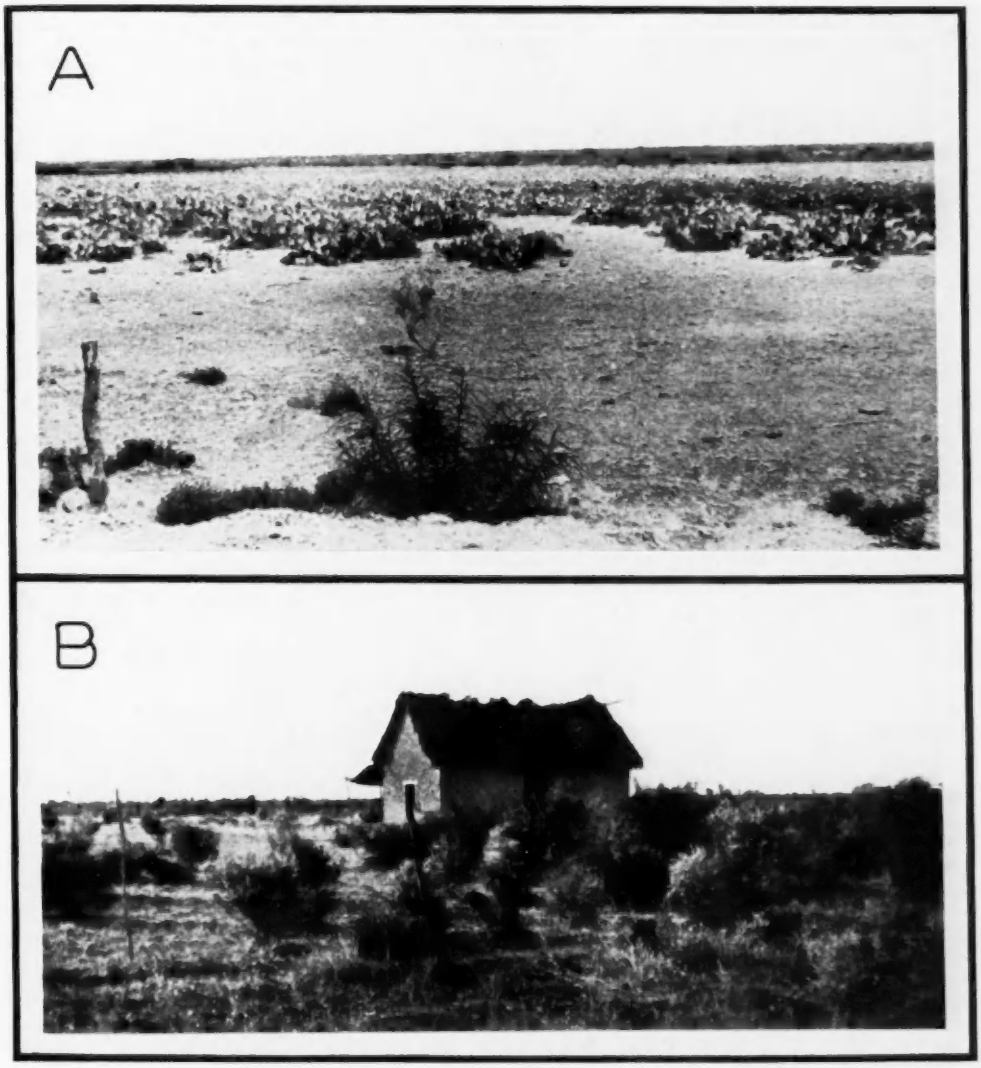

FIGURE 3.—Views from Landscape Type No. I. A.—Characteristic relief and natural vegetation a few miles south of Nuevo Laredo. Note the perfectly flat coastal plain. The cacti and low thorny brush are typical of this region. The only sign of human occupance is the fence post to the left, indicative of the grazing industry found even in these harsh surroundings. B.—Scene about three miles south of Vallecillo looking west. The adobe hut with thatch roof is the common type of dwelling along this arid northern segment of the highway.

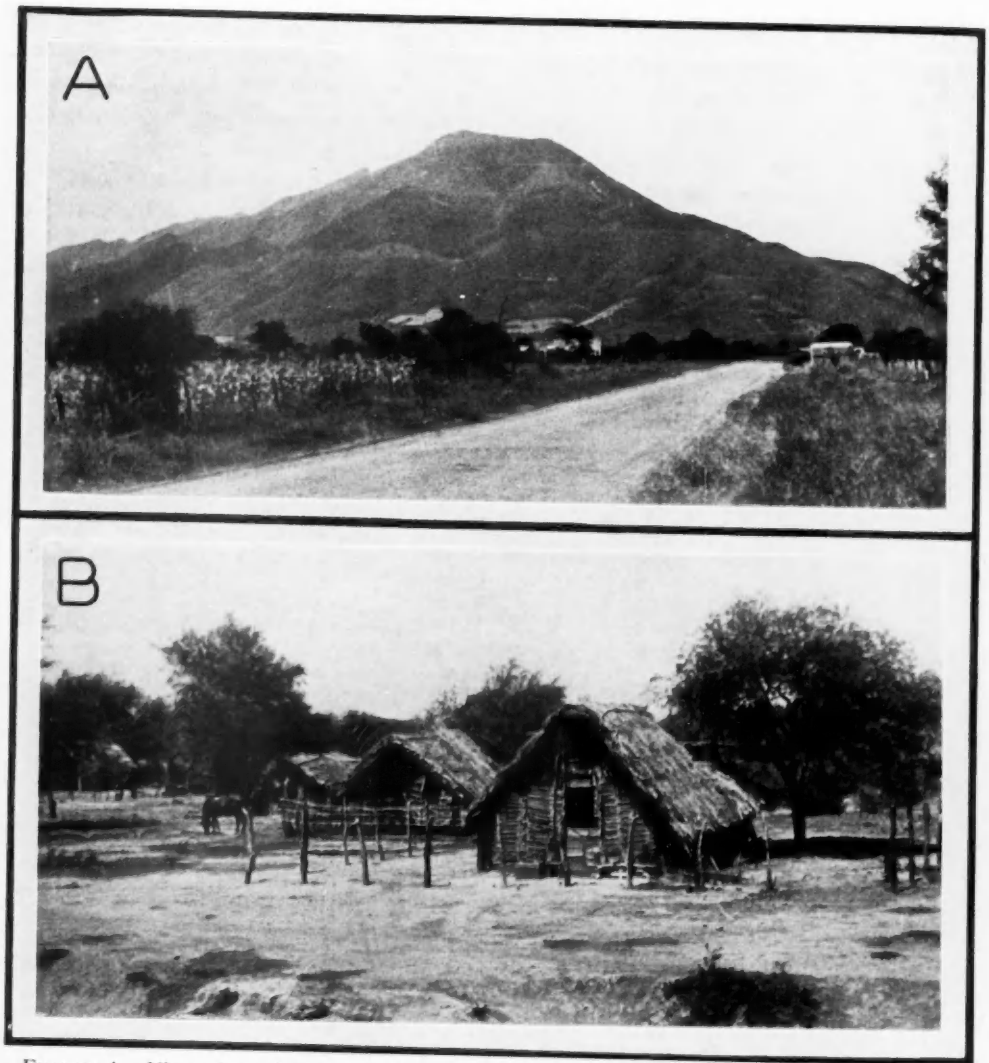

FIGURE 4.—Views from Landscape Type No. II. A.—About thirty miles south of Monterey, looking north. The gently-sloping piedmont is in the foreground; part of a dissected plateau spur is visible in the distance. Signs of human occupance are quite numerous in this picture, including a corn field, farm house, automobile truck (right center), road, telegraph poles along the road, and cleared patches on the mountain slopes. B.—The heart of a small village, about twenty miles north of Ciudad Victoria. The scattered low trees and brush huts are typical of this section of the highway.

sponse to increased rainfall, and villages and towns likewise become more closely spaced. The typical brush huts of the sub-humid region to the north are replaced in large degree by wooden or leaf huts. This, then, is the appearance of Landscape Type No. IV.

The conditions noted above continue for only a short distance, however. Increased elevation, as the ascent of the Plateau toward Jacala continues, causes such a reduction in temperature that true tropical conditions no longer prevail. Rainfall, nevertheless, continues to be abundant, except in the semi-arid enclosed mountain basins. (The landscape of these semi-arid enclosed mountain basins varies, depending upon whether or not sufficient water is available for extensive irrigation. Where

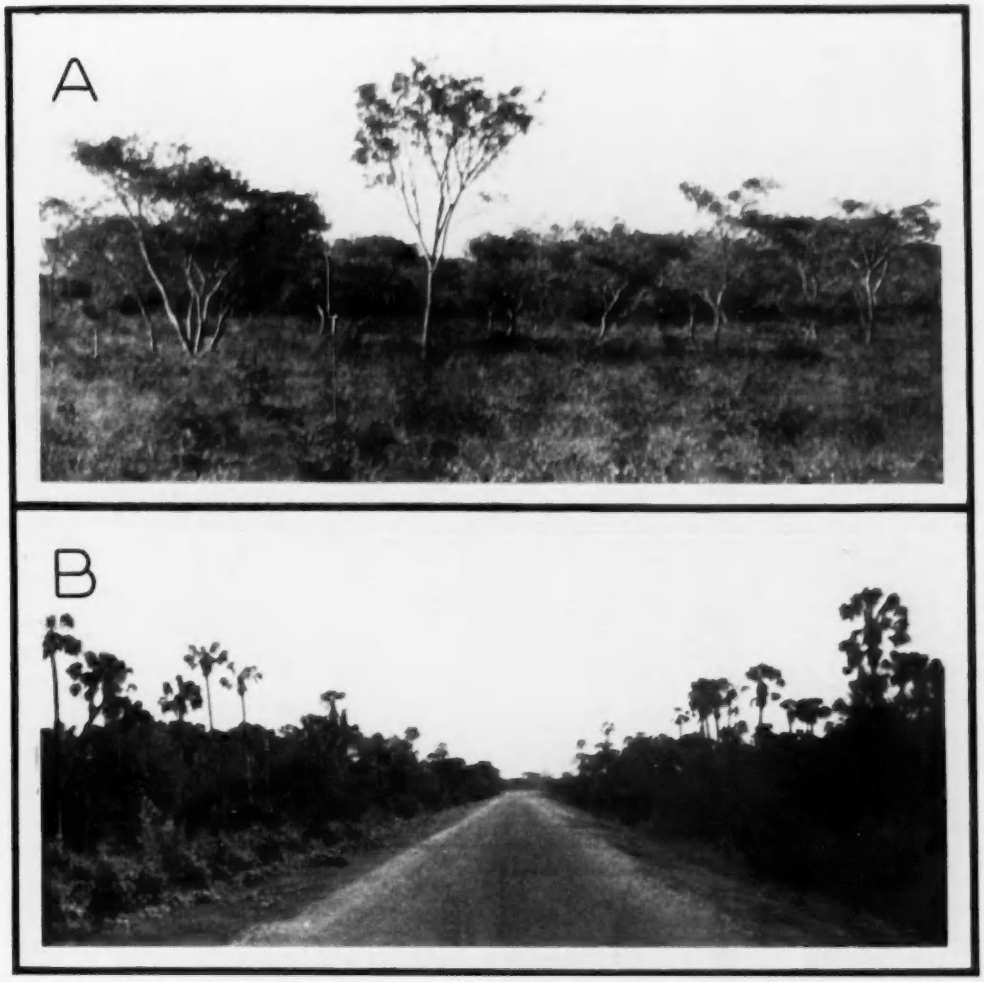

FIGURE 5.—Views from Landscape Type No. III. Characteristic types of natural vegetation along the Ciudad Victoria-Tamazunchale section of the highway. The acacias were photographed about ten miles north of Valles; the palms about twenty-five miles south of Llera.

irrigation is feasible, the land is intensively utilized; if water is lacking, then waste-land meets the eye of the traveler. See Figure 7-B.) Temperate forests of sweet-gum, oak, pine, juniper, and other similar species replace the tropical forests (Figure 7-A). Agriculture (corn and cattle) remains humid in character, but the tropical banana and the coffee plant disappear. These changes result in a sufficiently different naturo-cultural complex to justify the designation of this region as Landscape Type No. V.

Once the crest of the Mexican Plateau is achieved, and one begins to pass across the successive enclosed basins and mountain ranges that constitute the Plateau surface, a marked change in surroundings takes place. Rainfall diminishes again to semi-arid and arid proportions. Cacti and low, sparse shrubs and grasses become once more the dominant type of natural vegetation. Dry farming and irrigation agriculture again supplant humid-type farming. The giant maguey, together with irrigated corn and beans, become the most prominent visible crops. Stone

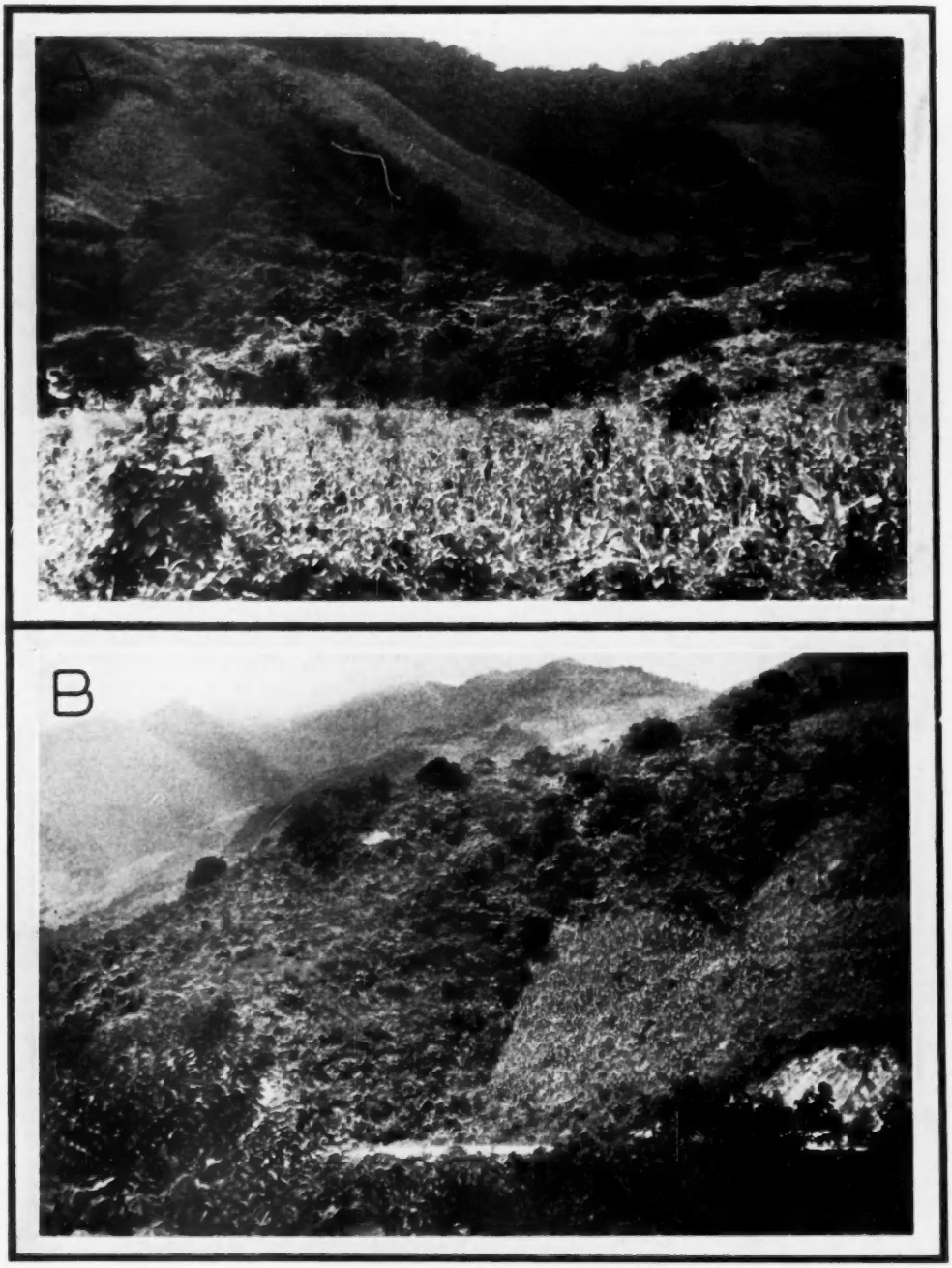

FIGURE 6.—Views from Landscape Type No. IV. The dissected edge of the Mexican Plateau, taken from a mountain valley near Tamazunchale. The ground is covered with a dense, low tropical forest, both in the lowlands and on the mountain slopes, in response to high temperatures and abundant rainfall. Corn fields and intertilled banana plants indicate the importance of agriculture along this humid section of the highway. Note the remarkably steep angle of inclination of the unterraced corn fields on the mountain slopes, and the newly burned field in the lower photograph which is being prepared for planting. Soil erosion is obviously a serious problem in this part of the country.

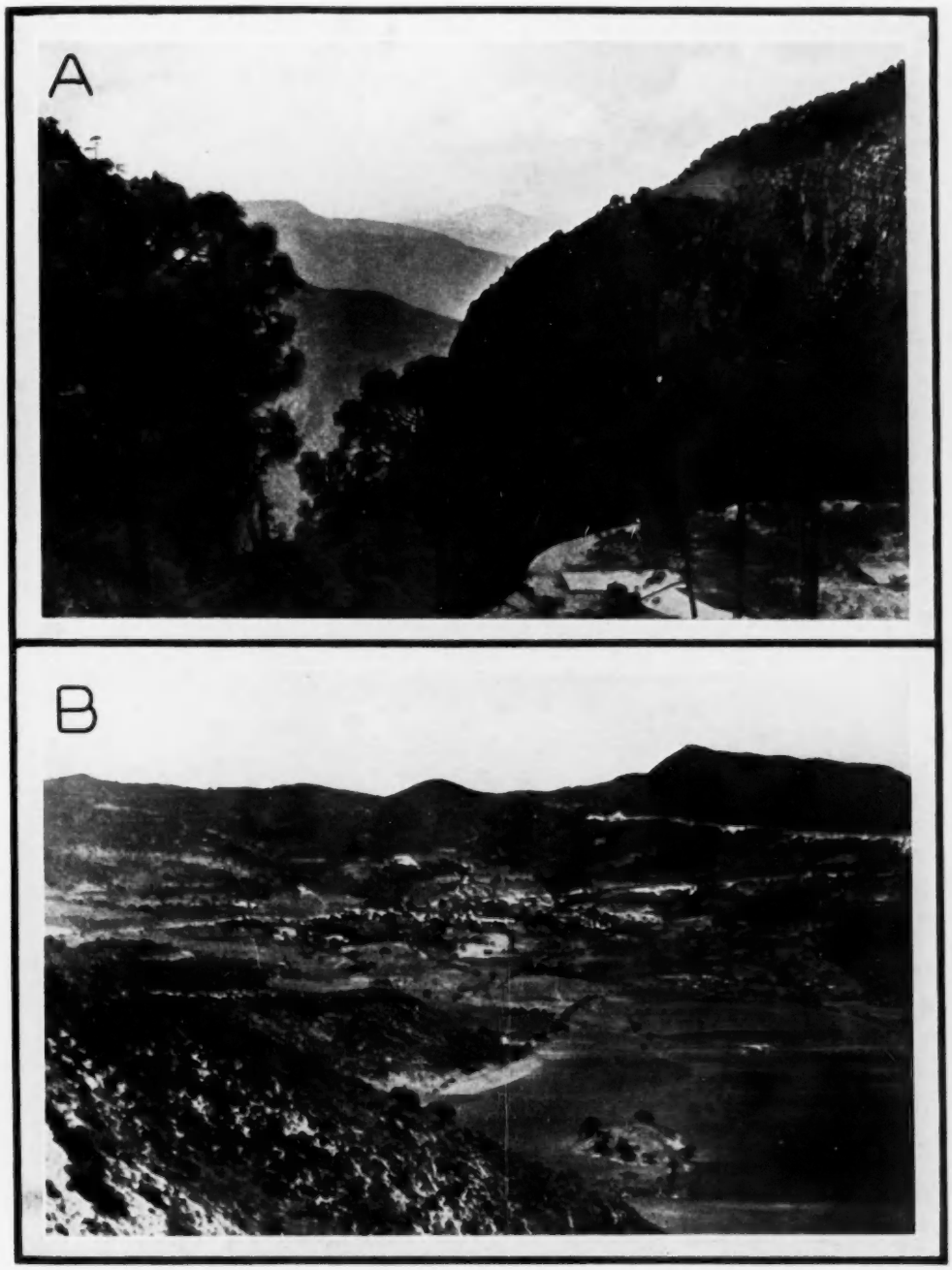

FIGURE 7.—Views from Landscape Type No. V. A.—View within the upper portion of the dissected edge of the plateau, about fifteen miles south of Jacala. Note the conifer trees in the foreground, and the cleared field in the lower right-hand corner. B.—Looking north across the irrigated Jacala basin. The enclosed basin is cut off from the moisture-bearing Gulf winds by the mountains in the background, but these same rimming mountains wring adequate irrigation water from the ascending air currents. The town of Jacala (white) is visible in the middle background; the Nuevo Laredo-Mexico City Highway (also white) can be seen as it crosses the basin and winds northward over the mountains.

or adobe huts replace the wooden, leaf, or brush huts of regions farther north. (Figure 8-A). These, then, constitute the items that make up Landscape Type No. VI along the Mexico City Highway.

The Valley of Mexico, the large enclosed plateau basin within which the City of Mexico is located, forms the last of the major landscape types encountered. Since there are relatively large quantities of water for irrigation purposes available from the high mountains that rim the Valley on the east, south, and west, and furthermore since the City of Mexico and its satellite towns offer the largest and most profitable market for agricultural produce to be found anywhere within the country, most of the land adjacent to the Highway and within the Valley is

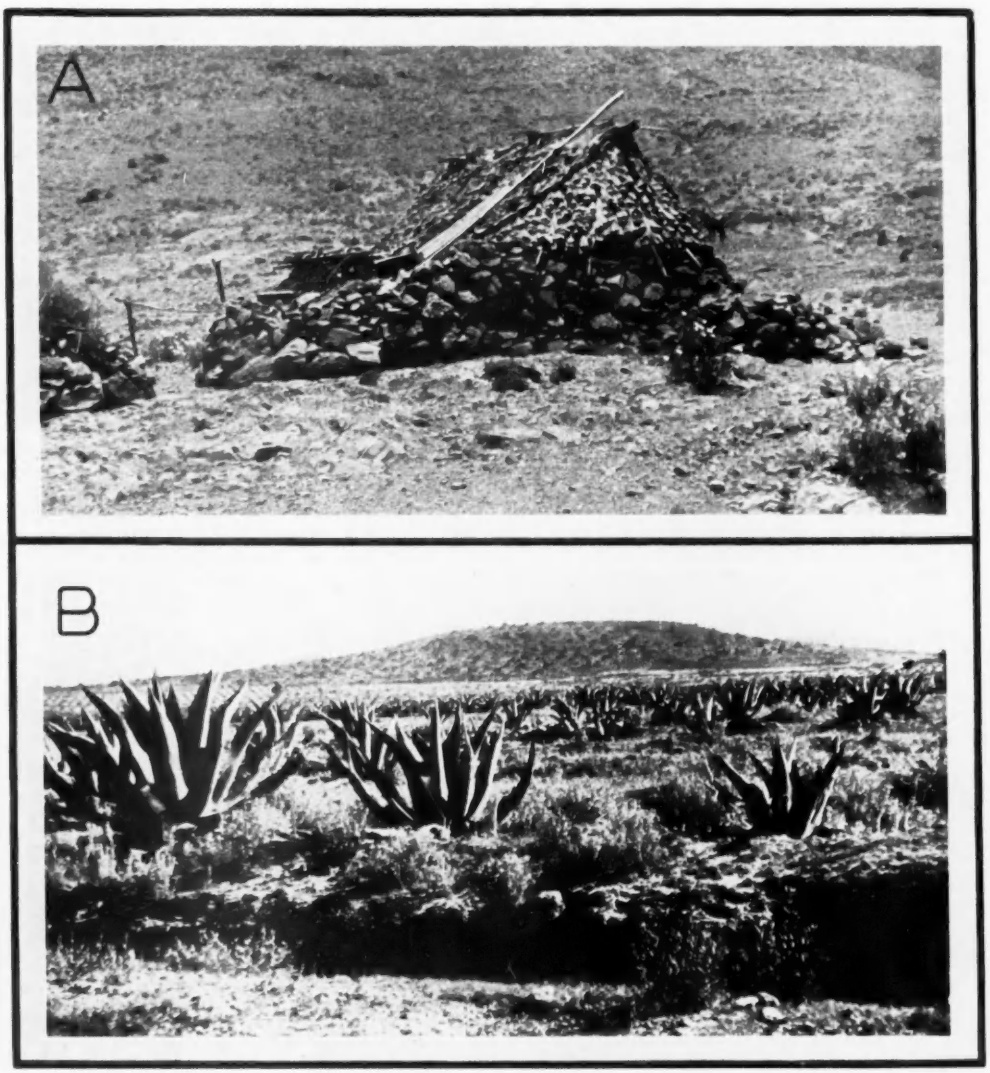

FIGURE 8.—Views from Landscape Types Nos. VI and VII. A.—An isolated rural dwelling, built of stone with cacti leaves for a roof. A few miles south of Zimapan, on the Mexican Plateau. B.—A maguey plantation, about fifty miles north of Mexico City, in the Valley of Mexico. Maguey plantations such as these stretch as far as the eye can see on both sides of the highway for many miles in the northern part of the Valley of Mexico. They dominate the landscape for this region.

utilized for agricultural purposes. In fact, the use of the land for farming is so extensive that the natural vegetation has largely disappeared from the area (Figure 8-B). Such propitious conditions for agriculture have resulted in the densest rural population that is encountered along the road. Hence, while rainfall and temperature characteristics, crop types, house types and other features remain essentially the same as in the Plateau area to the north, the appearance of a dense rural population intensively cultivating the land is sufficiently unique to warrant the classification of the Valley of Mexico segment of the Highway as Landscape Type No. VII.

CONCLUSIONS

The chart, Table I, represents an attempted résumé and correlation of the changes in certain natural and human conditions that occur along the Nuevo Laredo-Mexico City Highway. Ten major items are taken into consideration, four that relate to characteristics of the natural landscape and six that are concerned with some of the more significant features of the cultural landscape.

Evidences of human adaptations to changes in natural elements, that are reflected in this table, are striking. Types of agriculture, crop types, population density, house types, and other tangible human items indicate how closely man has shaped his material life to fit various combinations of topographic, climatic, and vegetative conditions. This close correlation between natural and human features has made possible the division of the country traversed by the highway into landscape types, each one characterized by a unique combination of elements.

It will be noted on this chart that the number of items that change at the junction of any two landscape types is not the same in all cases. For instance, between Types III and IV there are eight items that acquire a new aspect (in fact all but two of the ten enumerated), whereas between Types IV and V there are only three changes listed. On this basis one might venture the statement that adjacent landscapes of most drastic contrast are found where the road first begins to ascend the Plateau margin (between Types III and IV), and where it leaves the dissected margin at the crest of the Plateau (between Types V and VI). Likewise, the contiguous landscapes of least contrast might be said to occur within the Plateau margin (between Types IV and V), and on the Plateau itself (between Types VI and VII).

Such a quantitative evaluation, however, has its limitations. The chart by no means purports to include all features of the landscape; it comprises only a selected list. Furthermore, the various enumerated items are not of equal value or rank and hence are not comparable units of measurement. Nevertheless, the author does believe that a fair approximation of the changes that can be expected between adjacent landscape types along the Highway is to be gained by a simple arithmetical comparison of the items that differ.

In conclusion, it must be remembered that the statements characterizing the various subdivisions, in the chart as well as in the text, are based largely on reconnaissance trips and are not the result of intensive and detailed local studies. Hence, they may be subject to future modifications. Furthermore, it must be realized that the boundaries indicated are, in most cases, actually gradational and not sharply defined. The items enumerated, however, are sufficiently numerous and correct to furnish a large-scale concept of the landscape types encountered in the territory under consideration.

TABLE I—CORRELATION CHART OF CERTAIN LANDSCAPE ITEMS ALONG THE NUEVO LAREDO–MEXICO CITY HIGHWAY

Landscape Type	*Major Villages and Towns (populations approximate)*	*Relief*	*Rainfall (mostly summer rain)*	*Temperature*	*Natural Vegetation*
NO. I	*Nuevo Laredo* (25,000)	*Coastal Plain* (level)	*Arid* (approximately 15–25 inches annually; drought during greater part of year, but some summer rain)	*Sub-Tropical* (mild "winters"; hot summers)	*Desert Shrub* (cacti, yuccas, and agaves; low and scattered shrubs [acacias and mesquite]; grasses)
	Sabinas Hidalgo (10,000)				
NO. II	*Monterey* (185,000)	*Alternating Piedmont and Plateau Spurs* (level to rolling country, alternating with rugged land)	*Semi-Arid* (approximately 25–35 inches annually; rainy season about same length as dry season)		*Steppe* (*scattered* low trees [acacias]; *tall* cacti; shrubs and grasses)
	Linares (22,000)				
NO. III	*Ciudad Victoria* (20,000)		*Sub-Humid* [except humid windward slopes of several Plateau spurs] (approximately 35–45 inches annually; rainy season about same length as dry season)	*Tierra Caliente* (warm "winters"; hot summers)	*Scrub Forest and Palmetto Forest* (*closely* spaced low trees [acacias]; tall palmettos; shrubs and grasses)
	Villa Juarez (or El Mante) (7,000)				
	Valles (5,000)				
NO. IV	*Tamazunchale* (4,000)	*Dissected Edge of Plateau* (very rugged; mountainous)	*Humid* [except semi-arid enclosed mountain basins] (approximately 45–65 inches or more; has rain during more than half the year)	*Tierra Templado* (warm all year)	*Tropical Forest* (tropical trees; ferns, vines and epiphytes)
NO. V	*Jacala* (1,000)				*Temperate Forest* [except mountain basins] (sweet gum, oak, pine, juniper)
NO. VI	*Zimapan* (3,000)	*Plateau Basins and Ranges* (level to rolling country, alternating with rugged land)	*Arid to Semi-Arid* (approximately 15–35 inches; rainy season about same length as, or shorter than, the dry season)	*Tierra Fria* (mild the year round) { *Term Monthly Temps.* Mild—below 68° F. Warm—68° to 80° F. Hot—above 80° F. }	*Desert Shrub or Steppe* (see ditto above)
	Ixmiquilpan (3,500)				
	Actopan (2,000)				
NO. VII	*Mexico City* (1,300,000)				*Little Native Vegetation* (largely removed by cultivation; if present would be steppe)

Note: All statements and figures are approximations and do not attempt to take into account the wide *local* variations that exist. They merely represent an attempt to summarize conditions over large areas.

TABLE I—CORRELATION CHART OF CERTAIN LANDSCAPE ITEMS—*Continued*

Amount of Crop Land (great local variations)	*Types of Agriculture (grazing universal)*	*Most Prominent Crops and Animals*	*Rural Population Density (great local variations)*	*Frequency of Villages and Towns*	*Characteristic Type of Rural Dwelling*
Almost Non-Existent (only a few per cent of total area adjacent to Highway)	*Dry Farming and Irrigation Agriculture* (irrigation water from edge of Plateau)	Sheep and goats; some corn	*Sparse* (approximately from 1–25 persons per square mile) [a local moderate increase in rural population is found in the region about Monterey]	*Widely Spaced* (approximately one every 27 miles, on the average)	*Adobe Huts* (suitable vegetative materials scarce)
A Small Proportion of Total Area (less than one-quarter of total area adjacent to Highway, perhaps)		Corn, wheat, oranges, and sheep			*Brush Huts* (some adobe)
	Irrigation and Humid Agriculture (depending on type of crop)	Corn, sugar cane, and cattle			
A Moderate Proportion of Total Area (considerably less than half, however)	*Humid Agriculture* (except in irrigated, semi-arid mountain basins)	Corn, bananas, coffee, and cattle	*Moderate* (approximately 25–75 persons per square mile)	*Closely Spaced* (approximately one every 12 miles, on the average)	*Wooden or Leaf Huts* (numerous trees; adobe rare on steep slopes)
		Corn and cattle			
	Dry Farming and Irrigation Agriculture (water from mountain ranges atop the Plateau)	Corn, beans, maguey, goats, and cattle			*Stone or Adobe Huts* (suitable vegetative materials scarce)
Dominates Landscape (almost no uncultivated land adjacent to Highway)			*Dense* (over 75 persons per square mile)		

Note: All statements and figures are approximations and do not attempt to take into account the wide *local* variations that exist. They merely represent an attempt to summarize conditions over large areas.

TOMATO INDUSTRY OF INDIANA

W. D. Thornbury

MOST geographers are familiar with the importance of the Middle West as a vegetable canning area but probably few realize the outstanding position which Indiana holds as a canning state. It is the purpose of this article to point out the importance of Indiana in the canning industry and to discuss in some detail the growth of tomato production in Indiana.

Figure 1 shows the rank of the leading vegetable canning states, using the average of the 1935 and 1937 values of canned vegetables as given in the Census of Manufactures. It will be seen that Indiana ranks next to California in the canning of vegetables. The annual value of vegetables canned in Indiana is over $30,000,000. Indiana normally ranks among the first ten states in the canning of fourteen vegetable items. Its normal rank is shown in the following table:

Product	*Normal Rank of Indiana*
Tomato Juice and Cocktail	1st
Pork and Beans	1st
Kidney Beans	1st
Hominy	1st
Pumpkin and Squash	1st
Tomato Sauce and Catsup	1st or 2nd
Tomato Pulp and Purée	1st or 2nd
Canned Tomatoes	2nd or 3rd
Spaghetti	3rd
Sweet Corn	4th
Cucumbers (Pickles)	4th
Cabbage for Kraut	5th
Beets	6th or 7th
Peas	9th or 10th

While the human factor has played an important rôle in the location of some of the canneries in Indiana, geographic factors have had an important part in making Indiana outstanding in the canning of vegetables. Chief among the geographic factors which have favored Indiana are central location with respect to large urban markets, abundance of fertile glacial soils, level topography in much of the state, good climate, and adequate transportation facilities.

According to best accounts, canning started in the back of a grocery store in Indianapolis in 1861. At first the industry grew slowly. In 1884 only four plants were operating, but by 1894 the number had increased to 38. For the next forty years the industry grew rapidly and the peak in number of plants was attained in the late 30's when over 200 canneries were operating. In recent years there has been a slight decrease in the number of canneries. A careful check showed that 188 canneries operated during the 1940 canning season.

Distribution of Canneries

These 188 canneries are distributed through 59 of the 92 counties in Indiana. Figure 2 shows the distribution of canneries as of 1940. While the canneries are widely distributed over the state, there is a notable concentration of plants in east-central Indiana in the area of the level Tipton Till Plain of Wisconsin age. A significant relation exists between the cannery distribution and the glaciated and non-glaciated portions of the state. Fifteen plants are in the unglaciated section of the state; 20 plants are in the part of the state covered only by Illinoian drift; but there are 153 canneries in the part of Indiana covered by the Wisconsin ice sheet. The unglaciated part of

the state comprises 18 per cent of the state's area and has 8 per cent of the canneries; the area with Illinoian drift cover comprises 19 per cent of the state's area and has 10.5 per cent of the canneries; whereas, the area of Wisconsin drift comprises 63 per cent of the state's area and has 81.5 per cent of the canneries. One county, Madison, in east-central Indiana has 20 canneries in it. Thirteen counties in east-central Indiana have 99 canneries in them, or ten more than one-half of the state's total.

As in most industries involving a large number of producing units, there has been considerable mortality among the canneries, particularly during the last decade. Over fifty plants which formerly operated were not operating in 1940. A few of these were temporarily shut down but most of them were permanently closed. The number of closed plants is about equally divided between the northern and southern halves of the state, but as canneries were more numerous in the northern half of the state, the result has been a relative decline in the southern half.

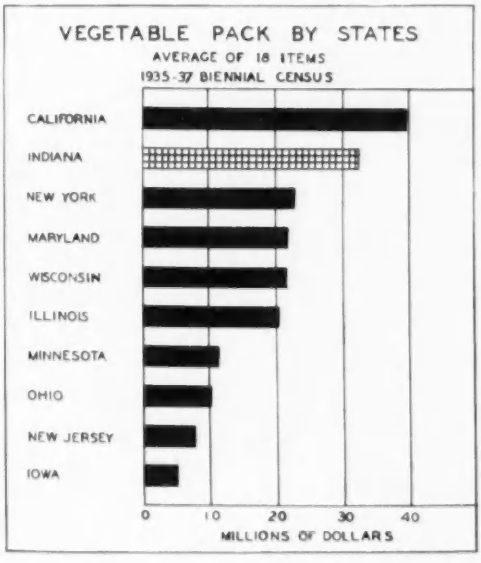

FIGURE 1.—Vegetable packs of the ten leading states based on the average of the 1935 and 1937 values.

By far the most important vegetable canned in Indiana is the tomato. The annual acreage of tomatoes grown normally is between 75,000 and 100,000 acres. Next to the tomato in importance is sweet corn. The sweet corn acreage is usually less than one-half as great as the tomato acreage. The rank of the leading vegetable products canned is shown in Figure 3, which is based upon the average of the 1935 and 1937 values for those vegetables whose annual value exceeds $500,000. Tomato products and sweet corn account for approximately two-thirds of the value of vegetables canned. The annual value of tomato products is slightly over $17,000,000 as compared with $4,000,000 for sweet corn. Pork and beans amount to over $5,000,000 and various kinds of beans to about $2,500,000. Peas, a relatively minor crop in Indiana, are worth slightly over $1,000,000.

THE TOMATO INDUSTRY

Six states, California, Indiana, Maryland, New York, New Jersey, and Ohio, produce over two-thirds of the tomato tonnage canned in the United States. Figure 4 shows the rank of each of these six states as based upon 1935 and 1937 production. It will be seen that Indiana ranks next to California in the value of tomato products. Figure 5 shows the rank of the various states in the canning of particular tomato products. That Indiana holds first place in the production of tomato juice and cocktail is probably due to the fact that a Hoosier canner pioneered in the field of developing a satisfactory method for canning tomato juice.

Tomatoes are raised in all of the counties but in many of them the commercial crop is small or lacking. Figure 6 shows the distribution of tomatoes in

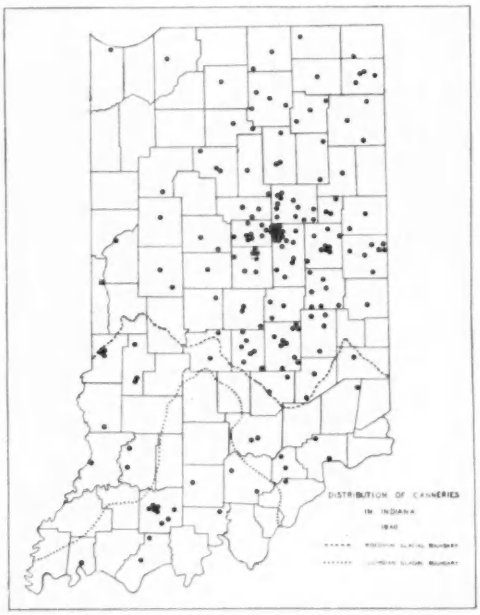

FIGURE 2.—Distribution of canneries in Indiana in 1940. Over 80 per cent of the canners operating in 1940 were within the portion of the state covered by Wisconsin drift.

Indiana based upon the five-year average from 1935 to 1939 inclusive. A five-year average is used rather than the acreage for a single year because of the fact that the acreage varies from year to year throughout the state due to local conditions affecting the demand at each factory. Only 11 of the 92 counties have less than 100 acres of tomatoes in an average year, yet, only 25 of the counties normally raise more than 1,000 acres of tomatoes. The commercial acreage is found largely in three sections of the state. The largest acreage is found in east-central Indiana in the area of the level Tipton Till Plain. A second area of importance extends southeastward from the Tipton Till Plain toward the Ohio River, coinciding essentially with the physiographic region of Indiana known as the Scottsburg Lowland, a lowland area not much over 600 feet above sea level and covered with Illinoian drift. A third area of less importance is in southwestern Indiana along the valleys of the Wabash, White, and Ohio rivers. Tomatoes are not widely grown in the hilly counties in the unglaciated part of the state or in the Northern Moraine and Lake Region. The unglaciated area has very little level land or fertile soil and the extreme northern part of the state is unsuited for tomatoes because of the large amount of morainal topography, poorly drained land, and sandy, gravelly, or muck soils.

Tomato acreage has undergone a rather significant shift in the past decade. There has been a notable decline in the importance of the southern counties and an increase in acreage in central Indiana. This shift is shown graphically in Figures 7 and 8. In Figure 7, a comparison is made between the ten leading tomato-growing counties north of the Wisconsin glacial border and the ten leading counties south of this boundary. The percentage of the state's acreage grown by each group of counties is shown for each year beginning with 1926. This method is used rather than plotting actual acreage per year in order to show the relative change which has taken place, since the state acreage has increased about 70 per cent since 1926. Figure 7 shows that the two groups of counties produced about the same per cent of the state acreage in 1927, 1928, and 1929, but that since then the southern counties have been producing an increasingly smaller percentage of the state's total. In 1939, the ten northern counties had 47 per cent of the total acreage, whereas the ten southern counties had only 16 per cent. The difference would be even greater if tonnage were compared because of the higher yields per acre in the northern counties.

This northward shift is also well shown in Figure 8 which compares the average acreage for the three-year period

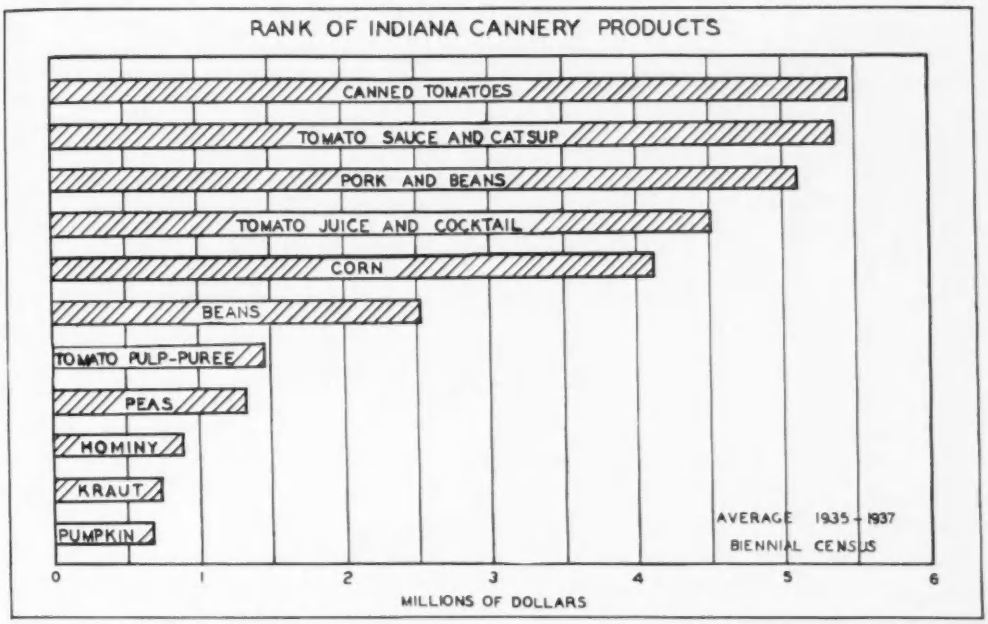

FIGURE 3.—Rank of Indiana cannery products whose annual value normally exceeds $500,000. Tomatoes or tomato products account for 53 per cent of the vegetables canned.

1927–28–29 with the corresponding period ten years later. Three-year averages are used because of the variations in acreage from year to year. The counties are divided into three groups: first, counties which had less acreage in 1937–38–39 than in the previous decade; second, counties which showed an increase in acreage, but below the average increase for the state during these ten years; and third, counties which showed an increase in acreage above the state average increase of 70 per cent. Only counties having an acreage over 200 acres were considered in making Figure 8, since we are concerned chiefly with the commercial acreage.

Eighteen counties showed an actual loss in acreage in the ten years and all but two of these are south of the Wisconsin glacial border. Nine counties showed a relative loss in acreage, five of which are south of the Wisconsin drift. Thirty counties showed an increase in acreage above the state increase and twenty-five of these are in the area of Wisconsin drift. Of the five counties south of the Wisconsin drift which showed increased acreage, four are in the area of Illinoian drift and one in the driftless area. The one county in the unglaciated area is unimportant, as its acreage is about one-tenth as great as that of the leading county in the state.

The explanation of this shift toward the central part of the state is not difficult to ascertain. The chief cause is the more productive soils in central Indiana. Particularly significant is the higher humus content of the soils there. As a result of the better soils, tomato yields are much higher in central Indiana, averaging from 50 to 100 per cent greater than those in most of the southern Indiana counties.

While better soils probably constitute the major reason for the higher yields in central Indiana, other factors are involved. The climate in the central and northern parts of the state is more nearly the optimum for tomatoes. The optimum climate for tomatoes is prob-

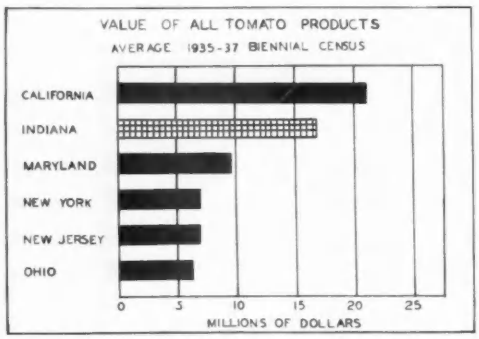

FIGURE 4.—Value of tomato products canned by the six leading tomato canning states.

ably not greatly different from that for corn. The highest tomato yields occur in general in the same areas where the highest corn yields occur. The higher temperatures and greater rainfall in southern Indiana, along with the fact that a more limited amount of good farm land causes fields to be put in tomatoes more frequently, make the problems of plant diseases more serious in the southern counties. Maximum temperatures above 85 or 90 along with heavy rainfall cause plant diseases to become a serious problem. Such conditions occur much more frequently in southern Indiana.

Another factor favoring the central and northern counties is the fact that the farmers there as a whole are more progressive and willing to coöperate with county agent and extension workers from Purdue University in their attempts to improve tomato yields and quality. This is indicated by the fact that tomato clubs are more numerous in central Indiana than in any other part of the state. Of the 69 tomato clubs in existence in 1940, four were in the driftless area, seven in the Illinoian drift region, and 58 in the area covered by Wisconsin drift. The percentage of clubs in southern Indiana is less than the percentage of tomato acreage.

Another factor which probably favors central and northern Indiana to a small degree is their location nearer to large urban markets and somewhat better railroad facilities.

METHODS OF GROWING TOMATOES

Tomatoes are grown upon a variety of soils but for best results the land must be well drained and in a high state of fertility and physical condition. A well drained soil favors root penetration to greater depths which results in more plant food and water becoming available to the plant. Loams and silt loams seem to meet best the requirements of the tomato. In the major tomato-growing section of central Indiana, about half of the tomatoes are grown upon either the Brookston or Crosby soils. The Brookston soil is the common "black soil" occurring on the level or slightly depressed Wisconsin plain. It is a silty clay loam possessing favorable tilth and high water-holding capacity as a result of its high organic content. Crosby is the upland brownish-gray soil of the same area and it too is a silt loam. It possesses somewhat better drainage than the Brookston soil. Third in importance among the soils is the Miami silt loam. It is somewhat lighter in color and better drained than either the Brookston or Crosby soils.

For soils high in organic content, where winter cover crops are not used and on which there is little danger of erosion, fall plowing is best. Fall plowing provides a better mechanical condition and greater water-holding capacity. For soils low in organic content, a green manure crop preceding the tomatoes is desirable. This is usually clover, alfalfa, or rye. Farmers who get the largest tomato yields also add to the tomato field from 10 to 15 tons per acre of animal manure before plowing and then apply from 400 to 600 pounds of commercial fertilizer per acre

at planting time. For most efficient use, the commercial fertilizer should be applied in bands on each side of the plant about 3 or 4 inches away and at a depth of 4 or 5 inches. The seed bed needs to be carefully prepared. It should be worked as thoroughly as if the farmer were intending to use the field for his garden.

There are two main sources of plants, southern-grown and home-grown plants. In central and northern Indiana, half or more of the farmers get their plants from southern states. Georgia, Louisiana, Arkansas, and Mississippi supply most of the plants. Georgia leads by far in supplying plants, providing close to 80 per cent of the plants used in Indiana. As many as thirty express cars a day may be shipped from the area around Tifton, Georgia, at planting time. Shipments usually begin about May 10. The plants cost the farmers about $1.50 per thousand and are distributed to the farmers by the canners. Some of the larger canners send inspectors to the southern states to avoid shipment of diseased plants.

The percentage of southern-grown plants used decreases as one goes southward. In the southern counties from two-thirds to three-fourths of the plants used are home-grown. Field studies carried on by Purdue University indicate that there is little difference in the yields obtained from home-grown or southern plants. The southern counties with their earlier spring are able to grow their own plants and save some expense, since from 3,000 to 4,000 plants are needed to set an acre of tomatoes.

A recent development in tomato planting is the practice of direct seeding, particularly in the northern counties. The tomato seeds are sown about an inch apart by means of a drill attachment to a corn planter (Figure 9). After the plants have reached a height of about 6 inches, they are blocked out by cross cultivation into rows from 3½ to 4 feet apart. Usually two cultivations are given the tomatoes before the blocking out is

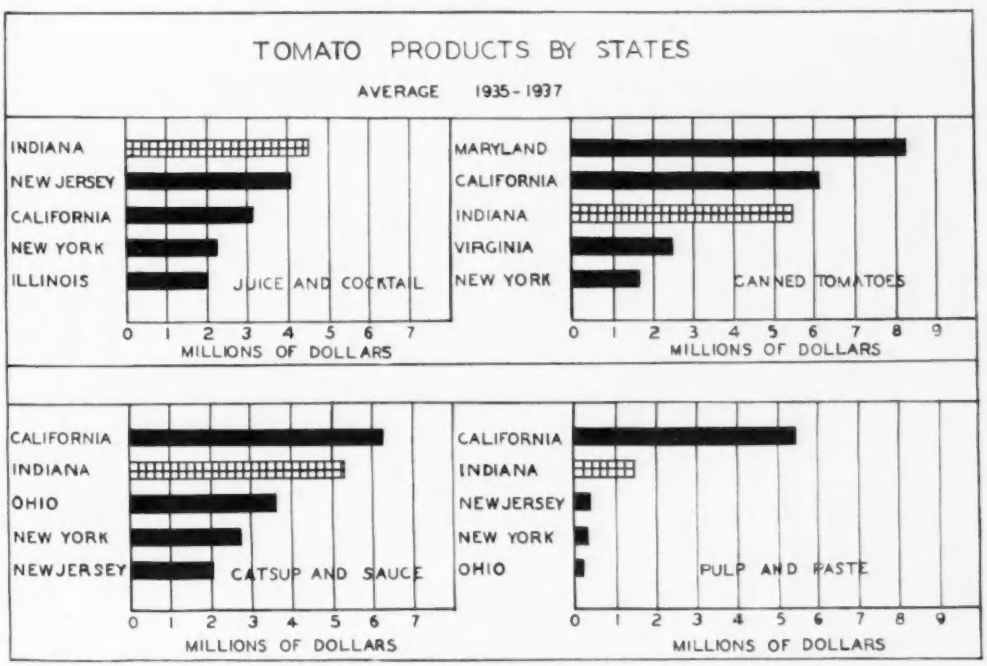

FIGURE 5.—Rank of the leading states in the canning of various tomato products.

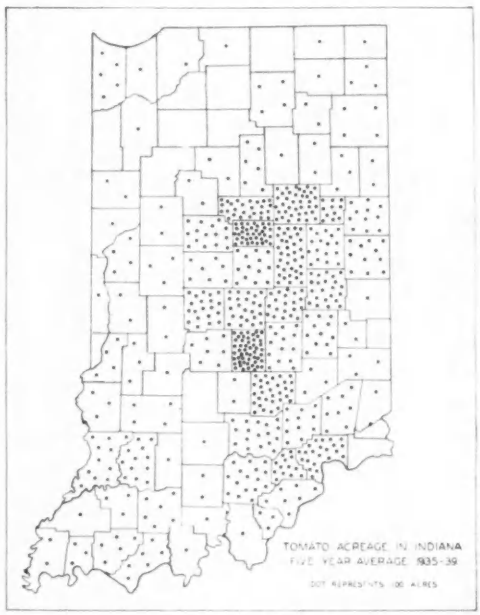

FIGURE 6.—Distribution by counties of the tomato acreage in Indiana based upon the five-year average from 1935 to 1939 inclusive.

done. This method requires somewhat better preparation of the seed bed than where plants are transplanted but makes possible the use of available farm labor and represents a saving of about one-half over buying and transplanting plants. Approximately 2,000 acres were direct-seeded in 1940 out of a total of 70,000 acres. As yet southern Indiana has done little direct seeding because the earlier spring there permits the growing of plants at home at little cost to the farmers. The yields from fields direct-seeded seem to compare favorably with those using southern plants. The chief objection to direct seeding is that if the weather is cold and wet after seeding, an incomplete stand may result which will necessitate the use of transplanted plants to fill in the gaps. In this case the transplanted plants will be late in ripening with resulting lower yields.

PROMOTION OF TOMATO INDUSTRY

In spite of the high rank of Indiana as a tomato-growing state, yields have not been as high as the abundance of excellent soils might lead one to expect. Average yields for the state for the past twenty years have ranged from 2.6 tons to 5.8 tons per acre. The average for the past twenty years is 4.2 tons, which is exactly the same as the national average for the same period. As an attempt to improve both yields and quality, in 1925, under the direction of Purdue University, the first Tomato Clubs were organized. The first clubs were known as the Ten Ton Plus Clubs. Growers who produced more than ten tons per acre were paid a bonus of fifty cents on the ton by the canners for each ton produced. Canners also agreed to award medals to the highest producers in each canning district in which clubs were organized. In the first year of operation fourteen canners agreed to try the plan and it was found that there was an increase in yield of three tons to the acre in the areas where the plan was tried. They also found that in addition to a tonnage increase per acre there was also a larger percentage of first grade tomatoes. In 1929, a few canners began to buy tomatoes on grade, paying more for No. 1 tomatoes than for No. 2's and culls. In 1932, the Ten Ton Plus Clubs were discontinued and the first so-called "U. S. Won" Clubs were formed, so named because a premium was placed upon the production of U. S. No. 1 tomatoes. Fifty-two such clubs were in operation during 1940. In 1936, to meet the needs in counties where tomatoes were not bought on grade, there were organized the first Double Tonnage Clubs. Members of these clubs are attempting to raise more than twice as many tomatoes as the average of the farmers in the area covered by their club. Seventeen such clubs were in existence in 1940. From five to eight thousand farmers annually participate in these tomato club contests.

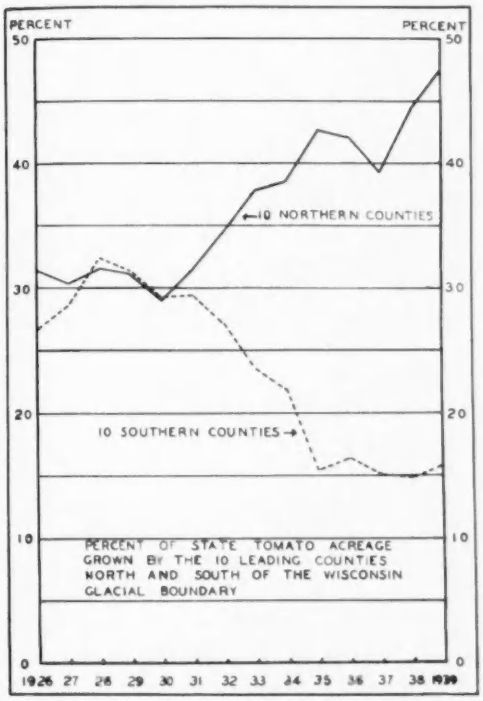

FIGURE 7.—Per cent of the state's tomato acreage grown by the ten leading counties north and south of the Wisconsin glacial boundary from 1926 to 1939.

The results obtained by many of the tomato club members are really amazing. While the yields vary considerably from year to year depending upon the weather during the growing season, the state winners in these contests have never averaged less than ten tons per acre and have on three occasions produced over twenty tons to the acre, or more than five times the state average. The highest yield which has been obtained by any club winner was that of the "U. S. Won" Club winner in 1937 who produced 26.02 tons of tomatoes which graded 87.9 U. S. No. 1's. This was over six times the state average for that year.

Nothing more strikingly illustrates the importance of good soils, careful cultivation, and wise use of mineral and animal fertilizers than a comparison of the yields of these club winners with those of the average farmers.

The geographic distribution of the club winners shows striking geographic influences. Out of the twenty-three state winners in the various types of clubs, three have come from the unglaciated part of the state, three from the area of Illinoian drift, and seventeen from the area of Wisconsin drift. Twelve of the twenty-three winners have come from three counties, Tipton, Clinton, and Howard, in central Indiana.

The Tomato Club results tend to emphasize the importance of the fine soils in central Indiana but they do show that the human factor is an important one, since on a few occasions highest yields have come from southern Indiana. However, the amount of land capable of producing unusually large tomato tonnage is definitely limited in the southern part of the state and in practically every case where a southern Indiana farmer has obtained the highest yield in his type of club, the tomatoes were raised upon the fertile alluvial soils along the Wabash, Ohio, or White rivers.

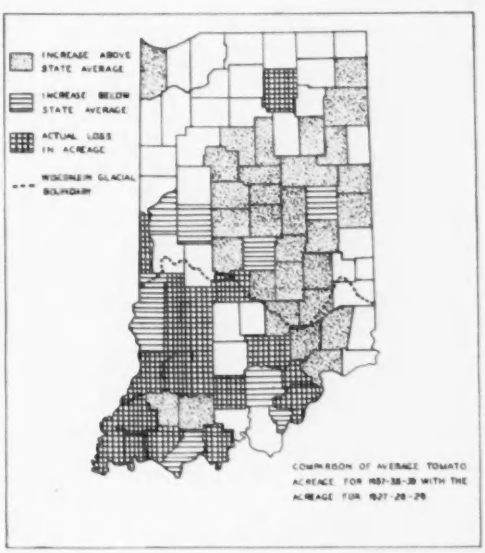
INCREASE ABOVE STATE AVERAGE
INCREASE BELOW STATE AVERAGE
ACTUAL LOSS IN ACREAGE
WISCONSIN GLACIAL BOUNDARY
COMPARISON OF AVERAGE TOMATO ACREAGE FOR 1937-38-39 WITH THE ACREAGE FOR 1927-28-29

FIGURE 8.—Changes in tomato acreage by counties during the past decade. With two exceptions, the counties showing an actual decrease in acreage are south of the Wisconsin drift border.

As a means of publicizing the tomato industry, there was inaugurated in 1937, at Elwood, in Grant County, what is called the State Tomato Festival. A Tomato Queen is selected after elimination contests by districts and she presides over the festival upon a throne decorated with tomato products. At the second Tomato Festival held in July of 1938 (Figure 10), an estimated crowd of 45,000 attended and a four-mile parade of floats passed by the reviewing stand. Elwood is often called the "Tomato Capital of Indiana."

Another method of advertising the tomato is the State Tomato Show which is held each summer at Indianapolis in one of its larger hotels. Several hundred dollars in prizes are given for the best exhibits of tomatoes.

Each year a State Tomato Picking Contest is held in which farmers compete to determine the state champion tomato picker. The pickers are graded upon both the quantity and quality of the tomatoes picked. The 1939 winner picked 18 hampers of tomatoes in 24 minutes.

GRADING SCHOOLS

The contests and festival described above may contribute much in the way of publicity for the tomato but they probably contribute little toward increased monetary returns except to the winners. Less spectacular but far more beneficial are the Tomato Clubs already discussed and the numerous grading schools held each summer (Figure 12). As a result of the efforts to improve the quality of Indiana tomatoes, more and more factories are buying tomatoes on grade. The usual procedure has been to pay $15 a ton for all U. S. No. 1 tomatoes, $10 a ton for U. S. No. 2's and nothing for culls. Federal inspectors are stationed at all plants buying upon grade. In order to enable the farmers to pick only good tomatoes, each year grading schools are held at various points throughout the state. At these schools the farmers are taught how to distinguish between No. 1, No. 2, and cull tomatoes. During the summer of 1937, seventy such schools were held which were attended by over 7,000 farmers. As a result of these schools fewer culls are coming to the factories.

FIGURE 9.—Direct seeding of tomatoes by means of a seeder attachment to a corn drill. As yet this method is not widely used. (Courtesy of Purdue University.)

A study made in 1938 by Purdue University showed that over 260 brands of tomatoes were offered for sale to Hoosier housewives. This study showed very definitely that the terms "Fancy" and "Extra Fancy" as used on most labels have very little significance. In order to offer something definite in the way of guaranteed quality, there was introduced in 1938 the "Hoosier Seal of Quality" label for use on tomatoes which met certain definite standards. All tomatoes bearing this label are guaranteed to be only U. S. No. 1 tomatoes, to have been federally inspected and passed, to be packed in new containers, and to be backed by a bond of performance by the grower. This scheme has been in operation so short a time that it remains to be seen how successful it will be but everything points toward ultimate success in educating the public to the value of the label.

About half of the tomatoes raised in Indiana are sold under the canner's label and the other half under the labels of the wholesaler or retailer. Several of the large national canning organizations operate their own canneries in Indiana but a few prefer to buy from the smaller canners and sell under their nationally advertised labels. Hoosier tomatoes are sold in practically every state in the United States.

PROBLEMS OF THE TOMATO INDUSTRY

There are three major problems facing the tomato growers of Indiana. These are the problems of markets, improvement of yields and quality, and defoliation. Increasing competition from other states and over-expansion following years of high prices have resulted in an increasing variation in acreage from year to year. A big tomato crop leads to a big pack and probably reduced acreage the next year in areas where the canners have not succeeded in disposing of all of their pack. This leads to much uncertainty among the farmers who depend upon the tomato as a cash crop. This situation is reflected in the large number of canners who have gone out of business in the last ten or fifteen years. The acreage for 1941 will probably be exceedingly large due to increased buying by the federal government and most canners are offering higher prices for tomato contracts but the ultimate results will probably not be beneficial for it will merely increase the tendency toward over-expansion and make more difficult the readjustments when times return to more normal conditions. The canners are trying to impress the farmers with the fact that 1941 contracts do not represent normal conditions.

The problem of improving the quality of tomatoes raised and thereby the prices paid the farmer is perhaps the fundamental problem facing the tomato growers. While more and more canners

FIGURE 10.—Tomato Queen for 1938 presiding over the State Tomato Festival which is held annually at Elwood, Indiana. (Courtesy of Purdue University.)

FIGURE 11.—Beginning of the state tomato picking contest for 1939. Similar contests are held annually. Winners are picked according to the quality as well as quantity of tomatoes picked. (Courtesy of Purdue University.)

are buying on grade, the bulk of the tomato crop is still sold on a flat rate. In general the income received on a flat rate is less per acre since the price paid per ton is low in order to make up for inferior tomatoes. However, the work of the Tomato Clubs and an increasing realization by both the canners and farmers that it is to the advantage of both to buy on grade give promise of continued improvement in the quality of tomatoes raised.

The problem of defoliation is one which has perplexed the tomato growers for many years and as yet little progress has been made toward its solution. Certain years have been marked by pronounced defoliation of the plants associated with excessive fungus growth. This is particularly bad during wet years and results in both poor color and quality in the fruit. In general about the time the farmers were becoming seriously concerned about defoliation good years followed with reduced defoliation and the problem was forgotten for the time. No systematic program of research has been undertaken but at the last session of the state legislature an appropriation was finally obtained for the inauguration of such a program which may in time produce permanent benefits.

FIGURE 12.—A tomato grading school in session. Hundreds of such schools are held annually under the direction of federal and state supervisors. (Courtesy of Purdue University.)

BORDERLAND OF THE WISCONSIN DRIFTLESS AREA

L. H. Halverson

ASTRIDE the eastern borderland of the Driftless Area some ten miles west of Madison lies Verona Township, with the village of Verona near its center. It is a rural area, with the major activities of the farmers centering in the production of milk, though hogs, cattle, wool and mutton, some grain, and other items may be sold off the farm. The function of the village is that of servicing the surrounding agricultural area, the village having about 100 persons within its boundaries, while the rest of the township has about 1,300 persons. Branching of state highways results in a rather extensive development of automobile servicing establishments.

The people are a heterogeneous mixture of various nationalities. In earlier times Verona was the center of a thriving Scotch settlement, to the north was a settlement of Germans, while to the south and southeast were Swiss. As the years passed many of the Scotch left the farms, and their places have been taken in the north by farmers of German extraction and in the south by people of Swiss blood. It is hardly possible that nationality today is of sufficient importance to merit much consideration as one views the activities of the people, though there may be some minor exceptions to this generalization.

The weather and climate over an area as small as a township show little variation, except locally, in relation to air drainage and topography. The average temperature for the three warmest months is about 69 degrees, so that the area is just upon the border of the optimum temperature belt of corn production for grain. While variations in elevation and air drainage conditions occur locally, in general it is possible for corn to mature fully in the average year even on low ground. The precipitation of about 31 inches is favorably distributed, about one-half falling in the months of May, June, July, and August. The thunderstorm is the principal type of summer precipitation, coming with spells of hot weather and high relative humidity. It should be recognized that in the later part of the summer, with high heat and rapid evaporation, some portions of the area with high relief may suffer from lack of moisture and the drying out of pasture lands.

There are marked variations in the topography and soils in the township, and related differences in the agricultural practices and land valuations.

Land Utilization

A statement that the driftless section of Wisconsin is inferior in productivity to the glaciated area might produce some controversy, since there are exceptional cases in each category. The comparison which follows, using as it does like-situated sections in the same township, can hardly be claimed to be an unfair sampling. It is not to be assumed that the areas are typical outside of this township.

The classification of lands according to their usefulness shows marked differences in the areas of surface suited to tillage crops in different parts of the township. The divergence in the agri-

cultural practices is shown in the subsidiary products found in some cases, even though the major activity is milk production. Figure 1 shows the types of land use at the time of the survey.

THE GLACIATED AREA

The western edge of the area of Wisconsin glaciation, the zone of terminal moraine, stands out in the concentration of woodlots, permanent pasture, and waste land (Figure 1). This zone

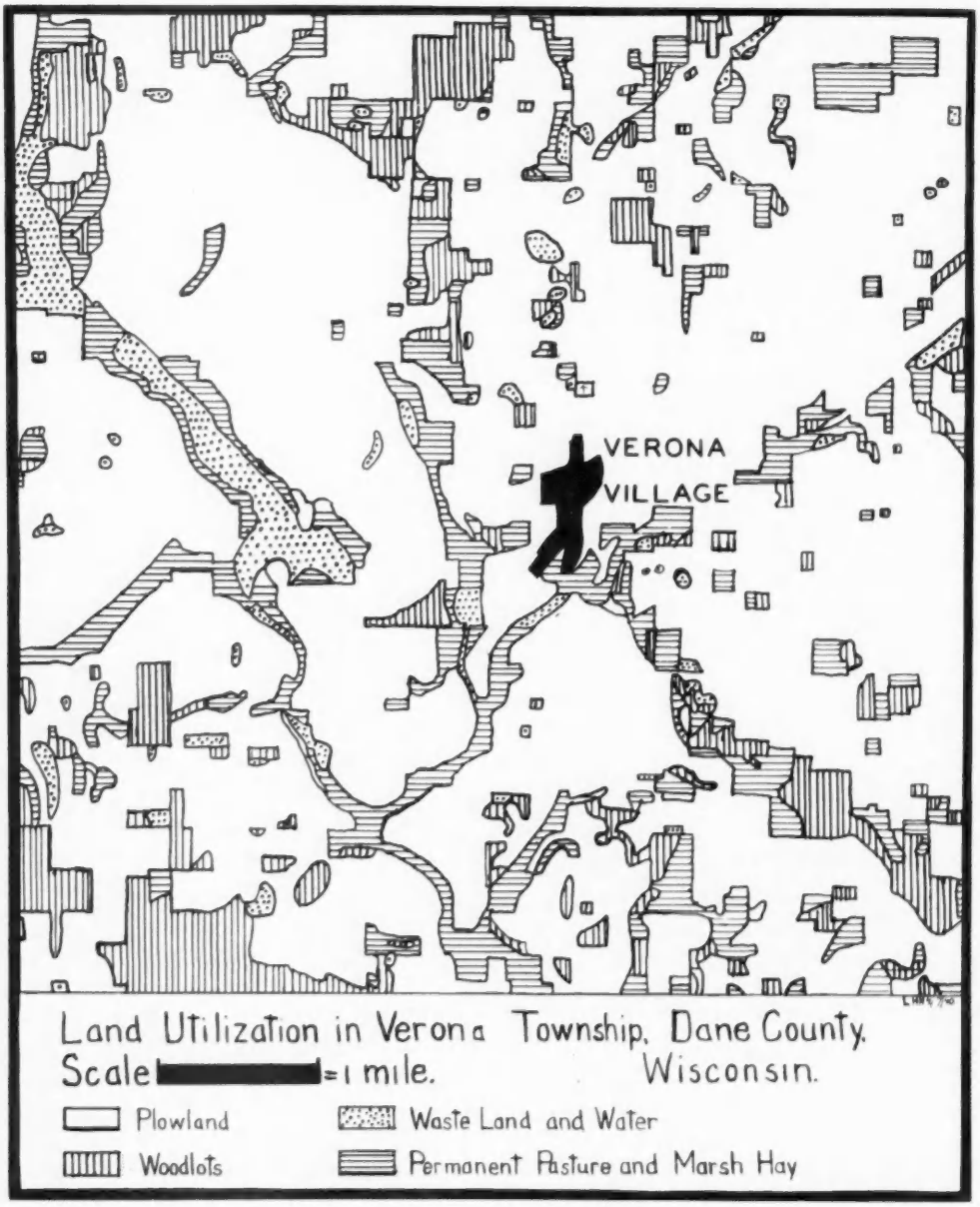

FIGURE 1.—Most of the waste land indicated in the glaciated area is due to undrained depressions of kettle hole character. In the intermediate area the ponding of drainage from the driftless section by glacial deposits resulted in marsh, largely waste land or pasture. The ground moraine portion of the glaciated area shows a high proportion of arable land.

is well defined from northwest to southeast on the map (Figure 2), except in section 8. The belt is narrow, so that no farms lie entirely within it, but overlap to the east and west. The relief, combined with poor drainage and many boulders, makes most of this land of little value except for woodlots and permanent pasture. It is common practice in the whole township to pasture the woodlots, though there are exceptions.

East of the terminal moraine is the ground moraine, making up the largest area of first-class farm land of a single type. Hay, oats, and corn are the common crops in the rotation. If there is no wet land or rough land on a farm, the owner pastures his hay land for a period before again plowing it. The lowland pasture fields are of great value to the farmer, as they are not so seriously affected by the late summer droughts which may occur, and so furnish valuable pastures at a critical time. The hay grown is clover, alfalfa, and timothy, with clover predominating. There is little wild marsh grass cut in the area, as most of the marshlands are more economically used as pasture. The large space in the frame portion of the basement barns which prevail makes possible the storage of practically all hay indoors, though the less valuable marsh hay may be stacked outside. The best hay is fed to dairy cattle, with inferior types fed to horses or other animals.

Oats is raised generally as a grain crop, and is fed to all types of livestock. A mixture of corn and oats in ground form makes excellent feed for both cattle and hogs. Corn is the most important tilled crop in this part of the township. The deep soils and gently rolling topography permit intensive tillage without endangering the soil if proper safeguards against erosion

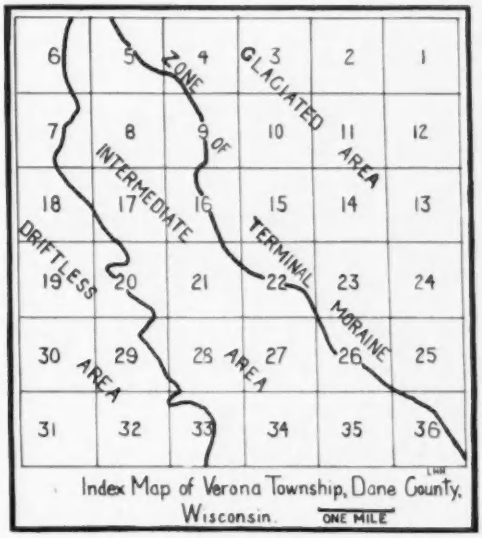

FIGURE 2.—Comparison of this map with Figure 1 shows the importance of wood lots and pasture in the terminal moraine zone. The sharp ridges of the unglaciated area likewise are in trees and pasture. Steeper slopes are plowed in the driftless section than elsewhere in the township. The gentle slopes of the northern portion of the intermediate area are largely arable.

are provided. Corn may be grown for grain or ensilage. From observation it appears that of the acreage planted, the large proportion is planted as a grain crop, though the actual use made of the crop depends upon the length of the particular growing season and the yield of the hay crop. With a short hay crop the farmer puts up more ensilage to carry his stock through the winter.

The importance of corn in the scheme of production is reflected in the number of hogs raised. Every farmer raises hogs which he fattens mainly on corn. The hog raising industry tends to influence the way in which the farmer disposes of his milk, and, as skim milk is a more valuable feed than whey, he prefers to have skim milk available for feeding on the farm. Therefore, the most satisfactory method is to separate the milk on the farm, and sell the

FIGURE 3.—Secondary road in the glaciated area. Good farmhouse on right. Available gravel has resulted in good roads in this portion of the township, though the pattern is not entirely rectangular, due to poor drainage or very rough morainal topography.

cream. This practice is not universal, as factors of location and transportation enter to complicate the situation. It is a fact that at the time of the survey there was only one cheese factory within this area proper, in section 23, though three others were located at the edge of the area.

Holstein-Freisian dairy cattle, largely grades, are raised almost exclusively in this part of the township, though there are a few herds in which there is a mixture of Brown Swiss blood. The presence of these Brown Swiss is undoubtedly a reflection of the nationality or fancy of the owner, rather than the result of any real advantages inherent in the breed in this area. In only three instances are beef cattle kept, each explained by other than geographic conditions.

Sheep are kept on a few farms and pastured on high grade land. The numbers are small, and as a rule they are found only on the larger farms. It is claimed that the presence of sheep is a result of the shortage of labor on the farms, which limits the number of dairy cattle that can be kept, even though enough feed may be raised to winter them. Sheep are insistent in their labor demands only in the lambing and shearing seasons, when other labor demands are light. The diversified agricultural activities briefly described are typical of the area before the period of the "depression." They afforded the most efficient use of the land, together with a balanced demand for labor, and thus gave the largest net income upon the capital invested.

THE DRIFTLESS AREA

This portion of the township offers the least friendly environment to agriculture, yet here the dairy farmer prospers to a degree one would hardly expect. He has little choice in his scheme of production, for he must conform within rather narrow limits, or bring ruin to the land and ultimately to the owner. The dairy cow stands supreme as an income producer. The scheme of production is centered in the milk yield, and other agricultural products are of much less importance than in other portions of the township.

The Holstein-Friesian breed again dominates in numbers, but Brown Swiss blood is also in evidence. It is claimed that the Brown Swiss are more thrifty "keepers" on the steep slopes which predominate in pasture areas. The valley bottoms, unless very poorly drained, are in tilled crops; while the undissected uplands, if any remain, are also tilled. In spite of some claims, it is apparent that the Holstein-Friesian cannot be under sufficient handicap in the area to cause it to be supplanted, for this breed actually far outnumbers the Brown Swiss.

One large herd of beef animals stands out as an exception to the general rule in this region. This herd numbers more than fifty animals, Herefords and Shorthorns of good breeding. Their owner makes a practice of producing two or three "show" steers every year. Beef production is supplemented by milk production, for twenty to twenty-five

cows of the beef breed are milked. A number of factors work to cause this herd to persist, rather than be replaced by dairy cattle. Probably inheritance is as important an influence as any, since the previous generation raised the same type of cattle, while the son of the present owner is fattening "baby beef" for stock shows now, and undoubtedly will carry on the herd in the future. A second factor centers in the farm of three hundred eighty acres upon which the herd is kept. The farm lies largely in the Driftless Area, but overlaps into the marshlands along the Sugar River, giving a large surplus of marsh pasture and hay land. There is so much pasture that an entire eighty acres of woodlot lies unpastured. On this large farm there is a proportionally large area of tillable land, on which corn may be produced for fattening beef cattle, as well as for ensilage. This scheme of production is peculiar for this area, and from observation it appears that it is continued in part, at least, from sentiment, rather than because it offers a more efficient use of the land. Herds of beef cattle are not so unusual in the extreme southwestern portion of the Driftless Area. The labor demand is much less than would be the case with an equal number of dairy cattle, and this may be one cause for the continuation of the scheme of production.

In the Driftless Area, the relative, as well as the total, acreage in corn is smaller than in the glaciated section. Much of the area is in such high slope that intensive tillage would result in rapid and destructive soil erosion. With a shortage of land which may be tilled with safety, with oats as a necessary crop for feed and as a cover crop for new seedings of hay land, the corn acreage must of necessity be smaller. Only the least sloping land may be plowed with safety more than two years in succession. The slopes also limit the size and weight of farm machinery used if horses are the tractive power. Each farmer grows as large an acreage of tilled crops as is possible with safety on his particular farm, and corn is always raised. Ensilage is important in the production plan of most farmers, though silos are not so numerous here as in the glaciated region. Contour plowing was common practice long before the Soil Conservation Service began its program.

FIGURE 4.—Profile of heavily pastured terminal moraine. In some places of this type, over-grazing and cattle paths have resulted in gullying of the till. Rough morainal lands are commonly pastured, even if in wood lots.

Hogs are universally raised, but are not so numerous as in the glaciated section. Only a few of the larger farms have enough relatively level land so that corn may be raised extensively enough to fatten many hogs. It is not usually profitable in this district to fatten hogs on purchased grain. Most of the farmers are patrons of cheese factories and receive whey as the residue of their milk. They consider whey to have about one-half the feeding value of skim-milk, which means a proportional reduction in the feeding resources of the farm. The hog pastures are large as a rule, often along a rocky ridge or on slopes which otherwise would be of little value. Such land is often covered with a poor stand of oak, and the hogs forage for the acorn crop.

Sheep are not common here, as all of the resources of the farmer are centered

in the production of enough feed to carry his dairy cows over the winter. The scheme is a highly specialized, one product type of agriculture: the one product is milk. In the more friendly environment of the drift-covered portion of the township milk is the most important product, but the farming is somewhat diversified, in that other products enter into the scheme, and are important sources of income.

A further idea of the landscape of the area is obtained from the fact that woodlots often are not pastured, due to the quantity of pasture without them. For purposes of comparison the three corner sections, 30, 31, and 32, are chosen as representative of the area. In the glaciated section the three corresponding sections, 1, 2, and 12, are chosen. In the three glaciated sections there are only twenty-five acres of unpastured woodlot, while in the unglaciated sections there are one hundred eighty acres, mainly unfenced. These data again indicate the excess of pasture in the unglaciated area.

INTERMEDIATE TRANSITION ZONE

In the intermediate area west of the terminal moraine of the Wisconsin ice, and east of the driftless surface, a variety of transitional conditions occur. The surface is made up of varying thicknesses of outwash and a probable thin older drift, which is relatively well drained. As in the Driftless Area proper, there is a loessial element in the surface soils. As a result of the aggradational material carried from the terminal moraine zone, the drainage of the Sugar River is obstructed, with resulting wet waste land in the valley bottom (Figure 1). In occupying this area the farmer encounters conditions more favorable than those of the driftless portion of the township, but in general less favorable than in the glaciated area.

FIGURE 5.—Type of poorly drained land in the glaciated area. Most of these depressions have water standing in them until late in the spring. The farmer in planting commonly encroaches on the area as far as the wetness of the ground will permit.

CONTRASTS IN SIZE AND VALUATION OF FARMS

In a township having such marked topographic and soil contrasts as the one under consideration, the expression of land values as given by the local assessors offers an interesting field of investigation. The data are for a rather typical year before the depression following 1930, and are taken directly from the Duplicate Assessment Roll of the Town of Verona. A comparison of the size of farms in various parts of the township bears out the conclusions already presented regarding the comparative productivity of the land in the two type portions of the township.

For the purpose of contrasting the glaciated and driftless portions the six sections already named will be used. The transitional area is extensive, so that a telling comparison could not result if larger areas were considered. The size of the farm homesteads in the two areas presents the first contrast. (By "farm homesteads" are meant farms actively worked as units in the area. This eliminates from the comparison idle lands with no buildings in the hands of speculators or non-resident owners.) In the selected sections in the glaciated area are seventeen farms, all or in part within the three sections, with

an average acreage per farm of 121.41 acres. In the driftless sections are fourteen farms all or in part within the three sections, with an average acreage per farm of 177.92 acres. The farms of the glaciated sections are comparatively uniform in size, while in the driftless sections extremely large farms alternate with much smaller holdings. In general the small farms are poor farms, as on a small farm the area capable of producing tilled crops is so small that the owner ekes out a very scanty living.

A second marked contrast is emphasized when the assessed valuations of land and improvements in the two areas are compared. The average assessed value per acre of land and improvements in the three sections in the glaciated area was $130.95; the land was valued at $99.97, while improvements per acre represented the sum of $30.98. Compare the above with a total per acre valuation in the three sections in the driftless area of $99.56; a land valuation of $84.81, and an improvements valuation of $14.65. It appears that the greatest contrast is in the value of improvements per acre, with this valuation in the glaciated area being slightly more than double that of the driftless sections. It seems unreasonable that the $85.00 land of the driftless sections should support improvements valued at only $14.65, while the $100.00 land of the glaciated area supports more than twice as great an amount.

The discrepancy must lie in the assessed valuations. Investigation indicates that the fault is not in the valuation of improvements, since improvements can hardly be hidden from the neighbors and the assessor. Investigation seems to indicate that the fault lies in the assessment of the land of the driftless sections. To the observer who bases his idea of a farmer's prosperity upon the number and quality of the dairy cows upon the farm, the two regions would show little contrast, since in some areas the driftless area has the higher dairy cattle population. Such a basis of evaluation entirely ignores the subsidiary or diversified products which are so important in enlarging the income of the farmer of the glaciated area. Such products are absent in any quantity in the driftless sections, or are produced only at a much greater expenditure of labor and capital.

In short, it must be concluded that the land in the glaciated area is markedly under-assessed. A farm in the glaciated section (NW¼ of NE¼ of 15: 40 acres) sold for $250 per acre. Deducting the value of the improvements as assessed, the land sold for $198 per acre. Since the assessed valuation of the land was $142, the sale price of the land was $52 more per acre than the figure at which it was assessed. In another case a farm in the glaciated sections sold for $43 per acre more than the figure at which the land was assessed. About five miles to the southwest in the driftless area at about the same time a farm of one hundred fifty-

FIGURE 6.—A secondary road in the sandy northern portion of the driftless section. The rectangular pattern here may be deranged by steep ridges. In one instance a fence was built by standing sandstone slabs on edge against trees, stretching one strand of barbed wire along the top, stapled to trees.

nine acres sold for $16,000; the assessed valuation was $16,000. For the land alone the assessed valuation was $84.91, the selling price $84.28 per acre. It is apparent that land in the driftless sections is assessed at its full sale value, while land in the glaciated area sold well above its assessed valuation.

CONCLUSION

From the data collected, and from their interpretation, it seems that the typical driftless section is inferior, in Verona Township, to equally typical glaciated territory. It is apparent that outward appearances to the casual observer are definitely deceptive. It is only by rather intensive investigation that it is possible to demonstrate the inferiority of the unglaciated area from the standpoint of successful agriculture. The relationships between assessed valuations and the selling price in the two areas is rather conclusive evidence of the over-assessment of the poorer land, the unglaciated land. Thus it is demonstrated again that the so-called "accident of glaciation" was a most fortunate occurrence.

SITE OF EARLY LOS ANGELES

Ruth E. Baugh

TWO maps of early Los Angeles help interpret conditions that influenced selection of site for its original settlement: first, the plan of the pueblo as sketched by Jose Argüello in 1786—five years after the founding—on the occasion of the assignment to the colonists of town lots and planting fields; second, the plan of the city in 1849, as surveyed by Lieutenant Ord of the United States Army.

Argüello's sketch demonstrates the simple plan of the customary Spanish colony adapted, obviously, to the particular conditions of the Los Angeles site; Ord's map, strikingly similar, shows functions of the city sixty-eight years after establishment of the pueblo.

Of great interest today is the fact that the area of parent settlement, the subject of these two early maps, is still nucleus of twentieth-century Los Angeles. The Civic Center now under development contains the parent core, notwithstanding a tremendous enlargement of the city's area in recent years.

The pueblo of Los Angeles was one of three civilian settlements founded in Alta California, to provide agricultural produce for presidios which were being established along with missions for the control of Spain's important northwestern frontier. Of the two colonies surviving the vicissitudes of early infancy, San Jose, the first to be organized, was planted in the fertile Santa Clara Valley south of San Francisco Bay, and received its settlers in November, 1777. A third civic community, Branciforte, was founded in 1797 near the site of the present city of Santa Cruz, but soon passed out of existence. Four years elapsed before arrangements were concluded for the founding of the second colony, although the location of the southern settlement had been chosen by Felipe de Neve, governor of Alta California.

The site of the southern pueblo, the broad terrace of the Rio Porciuncula, was located only nine miles west of the Mission San Gabriel. Here, in 1769, Don Gaspar Portola, on his northward journey in search of Monterey Bay, had halted "to reconnoiter the country, and above all else to celebrate the jubilee of Our Lady of the Angels of Porciuncula." ("Porciuncula was the name of a town and parish near Assissi which became the abode of Saint Francis after the Benedictine monks had presented him, about 1211, with a little chapel which he called in a jocular way, *La Porciuncula* [the small portion]" Nellie Van de Grift Sanchez, Spanish and Indian Place Names of California, p. 51, San Francisco, 1914.) The diarist of the expedition, Padre Crespi, noted in his journal, the charms of this locality: "We entered a very spacious valley, well grown with cottonwoods and alders, among which ran a beautiful river from the north-northwest, and then doubling the point of a steep hill, it went on afterwards to the south. Toward the north-northeast; there is another river bed which forms a spacious water-course, but we found it dry. This bed unites with that of the river, giving a clear indication of great floods in the rainy season, for we saw that it had many trunks of trees on the banks. We halted not very far from the river which we named Porciuncula. Here we felt three consecutive earthquakes in the afternoon and night. This plain

where the river runs is very extensive. It has good land for planting all kinds of grain and seeds, and is the most suitable site of all that we have seen for a mission, for it has all the requisites for a large settlement. . . . After crossing the river we entered a large vineyard of wild grapes and an infinity of rose bushes in full bloom. All the soil is black and loamy, and is capable of producing every kind of grain and fruit which may be planted. We went west, continually over good land well covered with grass." (Fray Juan Crespi, Missionary Explorer of the Pacific Coast, 1769–1774. Translation of diary by H. E. Bolton, pp. 147–149. University of California Press, 1927.)

Padre Crespi's account doubtless influenced Governor de Neve's choice of site for the southern pueblo. For twelve years the place had borne the name "Our Lady of the Angels of Porciuncula," and this name which was later applied to the pueblo was, in its abbreviated form, inherited by the

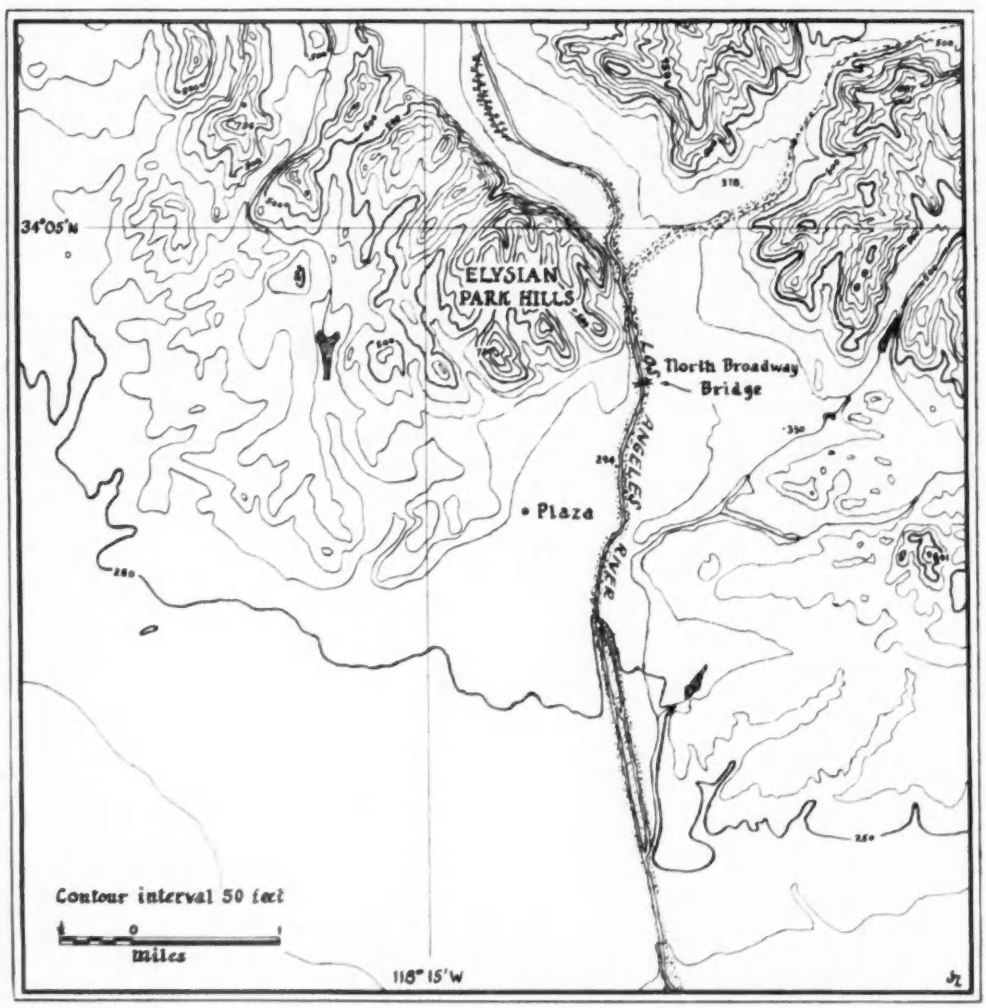

FIGURE 1.—Topography of central Los Angeles showing river, terrace, and hills of the site of the early settlement. The entire area included in this map is today the nucleus of the city of Los Angeles. (Adapted from U. S. topographic map, Los Angeles quadrangle, edition of 1900.)

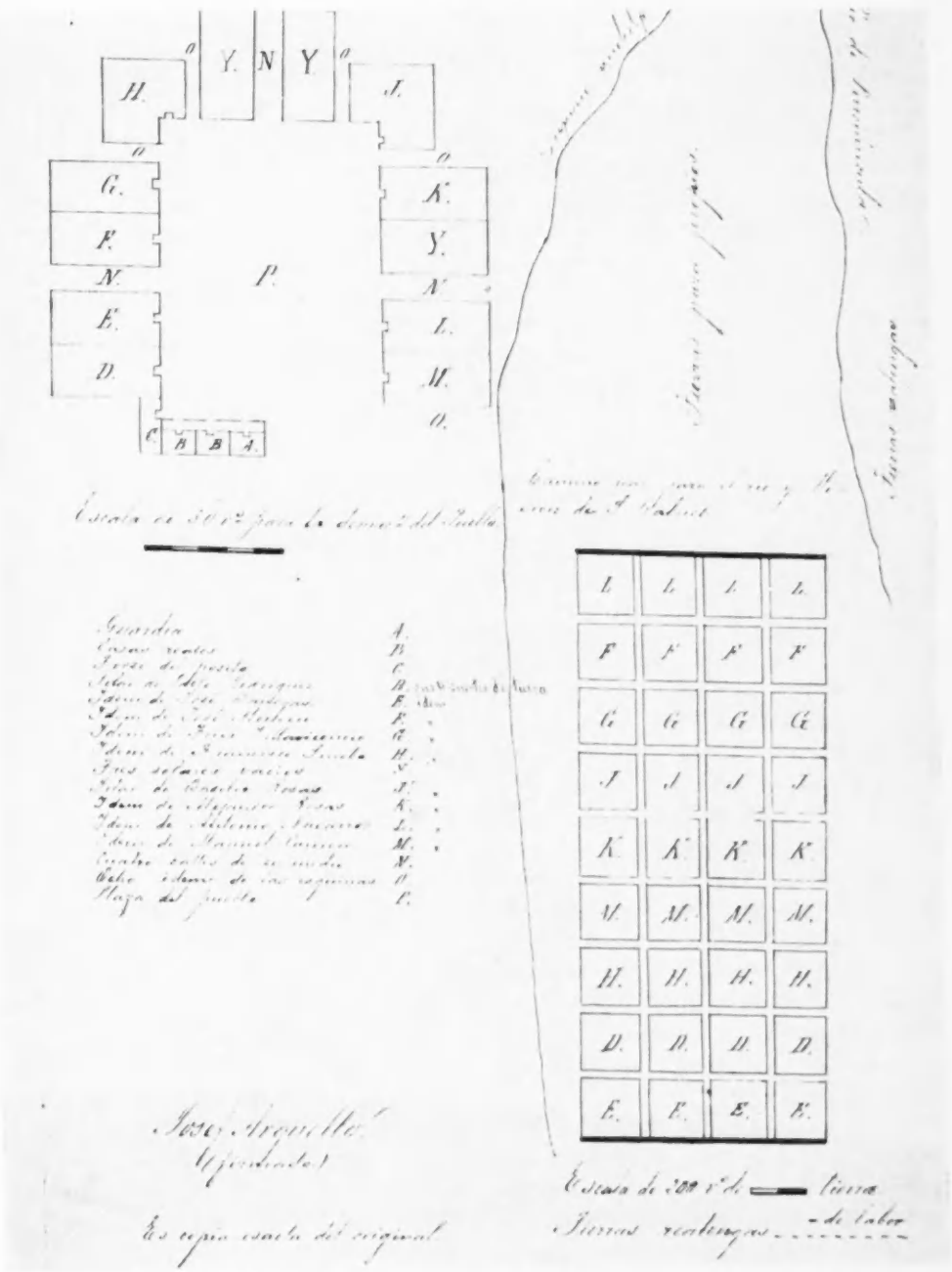

FIGURE 2.—Plan of the Pueblo of Los Angeles. Copy of the original sketch executed in 1786 by Jose Argüello on the occasion of the assignment to the colonists of the town lots and planting fields in accordance with Governor de Neve's Reglamento of 1781. The *propios* or municipal lands, the rents of which were used to defray pueblo expenses, lay between the Rio de Porciuncula (Los Angeles River) on the right, and the *azequia madre* (mother ditch) in the center of the sketch. Fronting the plaza (P) were the house-lots and spaces reserved for municipal buildings. The King's Highway connecting the San Gabriel Mission enters the plaza at O. The names of the nine heads of families to whom lands were granted are here listed. The scale used in mapping the pueblo proper is four times larger than that used for the fields. (From the Provincial State Papers, Archives of California. Tom. III–IV, p. 55. Bancroft Library, University of California.)

city of Los Angeles. With this location in mind, the governor prescribed the conditions for the settlement:

"For the establishment of the Pueblo of Los Angeles, near the river Porciuncula, and on the land designated for this purpose, there shall be included all the lands that may be benefited by irrigation. There shall be marked out the best place to construct the dam in order that the water may be distributed to the largest extent of land.

"The site where the Pueblo is to be established shall be marked out, on land slightly elevated, exposed to the north and south winds. Measures shall be taken to avoid the dangers of floods; the most immediate vicinity to the river, or vicinity to the principal zanja shall be preferred; taking care that from the Pueblo the whole or greatest part of the planting lands shall be seen." (Order of Governor Felipe de Neve for founding of Los Angeles. Translation by Phil Townsend Hanna in the Publications of the Historical Society of Southern California. Vol. XV, Pt. I, pp. 154–155. 1931.) To this site, two leagues west of San Gabriel, a small group of Spanish soldiers escorted the forty-six settlers who had been recruited in northern Mexico, and with fitting ceremony formally founded on September 4, 1781 *El Pueblo de Nuestra Senora La Reina de los Angeles.*

The area chosen was eminently satisfactory for an agricultural colony. If at first the land yielded poor returns, the cause lay in unskilful cultivation and not in adverse natural conditions. Rainfall was far from adequate, it is true, but the *pobladores* were accustomed to an even scantier precipitation in the Sonoran desert. Spanish officials and Franciscan friars were familiar with the moisture deficiencies of the Mediterranean climate and knew the requisite agricultural practices, particularly that of irrigation, utilized in the European homeland to overcome the handicap of a long, dry summer. Thus water was the critical factor in agricultural production on this Pacific Mediterranean littoral, for without it even this fertile soil would yield but a niggardly return. The determining element, therefore, in the pueblo's location, was the presence of a small stream.

The Rio Porciuncula (Los Angeles River) enters the plain a few miles above the town site, discharging a clear rivulet from the saturated gravels which underlie the San Fernando Valley. The stream constitutes the overflow from a subterranean reservoir; hence its volume, though meager, was fairly constant as far down as the pueblo. Below that point it diminished in volume and finally was lost in the sands of the deep gulch in which it is entrenched. Occasionally, however, swollen by torrential winter rains, it became a turbulent river and occupied its arroyo from bank to bank.

To escape the winter floods and to facilitate the distribution of irrigating water, the pueblo was laid out on the broad terrace about half a mile west of the arroyo's edge. A simple dam was constructed two miles upstream where the river rounded the steep bluff of the Elysian Park Hills, and from this point water was diverted into *zanjas*, thence on to the high level of the terrace and to the pueblo and planting fields beyond. Here the ground was level, but with sufficient slope to insure good drainage. (Figure 1.)

The intermediate location of the terrace between the entrenched river on the east, and an irregular line of hills rising abruptly on the west, hemmed in the little settlement and created an easily defensible site, an advantage which fortunately was not put to the

FIGURE 3.—The plan of the city of Los Angeles in 1849, as surveyed and drawn by Lieutenant E. O. C. Ord of the United States Army. Ord's map includes a part of the area shown on Argüello's sketch. The point of intersection of the two coördinate lines of the Ord map is the parish church which fronted the plaza in 1849, as it does today. This location, however, is not identical with that of the original plaza because the pueblo in the early years of its history was forced to move back from the river to escape destructive winter floods. Vineyards and gardens occupied the entire area of the level terrace between the river and the main irrigation ditch, whereas the newly plotted business and residential district was laid out near the base of the hills. The piedmont road in the left center of the map is the Spanish trail which Portola followed in 1769 on his march northward in search of Monterey Bay.

test during pueblo days, for the natives encamped in the rancheria of Yang-na, located "among the woods on the river's bank" appear to have received hospitably Spanish conquistadores as well as Mexican immigrants.

The general situation of the pueblo was no less favorable than its site. Grass covered plains stretched continuously to the ocean, twenty miles to south and west; they were to become within a few decades the grazing grounds of thousands of cattle, horses, and sheep. Beyond the knolls and ridges east of the river lay the fertile valley lands tributary to the Mission San Gabriel, the outpost which provided physical and spiritual sustenance to the infant colony. Twelve miles to the north, there rose from the plain a mountain wall, the *Sierra Madre*, nurturer of mountain streams, and truly a mother to the infant settlements planted in the valleys of semi-arid southern California; indeed, this range is no less a mother to groves and gardens which today lie at her feet.

The pueblo plan, adopted for Los Angeles, was utilized by Spain in her colonies throughout North and South America. It comprised a village in which house lots faced a common square or plaza, with planting fields and pastures beyond the residential precincts. According to the governor's instruction, the pueblo should contain four square leagues (28 square miles). In the geographical center of this area "a plaza 200 by 300 feet was to be laid out with its corners facing the cardinal points and with streets running perpendicularly from each of its four sides." (H. H. Bancroft, History of California, Vol. I, p. 345.) Lands were apportioned so that each settler received a house lot as well as a share in the *suertes* or sowing fields. The west side of the plaza was set aside for the church and government

buildings, while east of the river were the *realengas* or royal lands.

The first community task of the *pobladores* was the construction of the mother ditch, which conveyed domestic and irrigating water to the pueblo and its fields. The settlers doubtless attempted some cultivation during the first year of the colony's existence, but records of production are lacking. By 1786 the colony was apparently self-supporting, for in that year government aid was withdrawn. Jose Argüello, under the Governor's direction, executed the final distribution of property, guaranteeing the title of each settler to a house lot and four fields—two *suertes* of irrigable land and two of dry. The accompanying sketch of the pueblo (Figure 2) included in the territorial records of Alta California shows the location of residence plots fronting the plaza, and of the *suertes* in the area between the main ditch and the river. *El camino real* which ran out to Mission San Gabriel, crossed the Rio Porciuncula and *zanja madre* just north of the planted fields. (Archives of California, Provincial State Papers, Tom. III–IV, p. 55. Bancroft Library, University of California. The map of the pueblo is on a scale four times larger than that of the fields.)

But to the close of the century, the accomplishments of the pueblo hardly justified the establishment of the colony. By 1800 the population numbered only 315. In 1822, Mexico threw off the yoke of Spain and became a republic; thereupon for more than two decades California's affairs were administered by Mexican governors. By the arrival of traders and trappers from Santa Fe and of foreigners who reached the west coast in American and English ships, the population slowly increased. The designation of Los Angeles as capital of Alta California—a temporary arrangement only—and the promotion of the pueblo to the rank of a city resulted in an ever-growing demand for house lots. But imperfect titles and lack of maps and records made the transfer of land difficult. Judging by the minutes of its meetings, one is led to believe that the granting of lots and the confirmation of titles was the major business of the local *ajuntamiento*, or town council, throughout the decade preceding the American conquest. (Proceedings of the *Ajuntamiento* in Los Angeles City Archives.)

This confused state of affairs persisted until the territorial governor in 1849 requested a map of the city and information pertaining to the granting of lots. (Guinn, James M., History of Los Angeles, Vol. I, p. 266.) Lieutenant E. O. C. Ord of the United States Army was commissioned to survey the city and, in addition, was instructed by the local council to sketch "all lands actually under cultivation from the principal water-dam down to the last cultivated field below. As to the lots that should be shown on the map, they should begin at the cemetery and end with the house of Bottiler. As to the commonalty lands of this city the surveyor should determine the four points of the compass and taking the parish church for a center, measure two leagues in each cardinal direction. These lines will bisect the four sides of a square within which the lands of this municipality will be contained, the area of the same being sixteen square leagues, and each side of the square measuring four leagues." (Los Angeles City Archives. Vol. IV, pp. 590–594, 1849.)

The results of Lieutenant Ord's survey are embodied in the "Plan de la Ciudad de Los Angeles," completed August 29, 1849, today a highly prized record in the city's archives as it is the first authentic map of the city of Los Angeles (Figure 3). Although Ord's map records

FIGURE 4.—The pueblo of Los Angeles as sketched by H. M. T. Powell, March 17, 1850. This view of the settlement was made seven months after the completion of the Ord map (Figure 3). (From "The Santa Fe Trail to California, 1849–1852," the Journal and Drawings of H. M. T. Powell. Edited by D. S. Watson, San Francisco, 1931. Sketch used by permission of the Book Club of California and the Grabhorn Press.)

conditions in 1849, it enables us in the light of historical facts to reconstruct the physical aspect of the original pueblo, and to interpret the rôle played by the three dominant geographical features: river, terrace, hills.

The map shows that the Los Angeles of 1849, like the pueblo of 1781, centered round the plaza. On the west, the town was sharply delimited by hills which presented a steep front to the settlement, while on the east, the utilized area stopped abruptly at the brink of the dry wash in which flowed the intermittent Los Angeles River. The residential section occupied the higher ground west of the zanja madre and Calle Principal, whereas the cultivated fields lay east of, and slightly lower than, the mother ditch.

The zanja madre had to tap the river far enough above the pueblo to allow the diverted water to flow by gravity to the terrace, which is elevated above the stream level at the town. Originally a crude dam of brush and poles was thrown across the river two miles upstream. (The original intake was located in the vicinity of the present North Broadway bridge, according to

the late Charles J. Prudhomme, who came to Los Angeles in 1855, and who was for many years an engineer in the Los Angeles Water Department.) From this point the main conduit ran southward, following the base of a low scarp (probably Alameda Street) to a point above the plaza where it bifurcated into two major ditches, one of which carried the domestic water supply to the pueblo, the other, the irrigating water to the fields. As population increased and the cultivated area was extended, the ditches were lengthened until a general zanja system served the pueblo. This system, improved and enlarged, was utilized for more than a century.

On the sunny terrace sloping gently to the river lay the cultivated fields. Ord's map indicates that grapes were the dominant crop and were given preference of location: they were planted nearest the zanja madre for adequate water, and removed far enough from the river to escape the ravages of winter floods. Major Emory, who passed through Los Angeles the year of the Ord survey, noted that "of the many fruits capable of being produced with success (in Los Angeles), by culture and irrigation the grape is perhaps that which is brought nearest to perfection." (Emory, W. H., Notes of Travel in California from the official reports of Colonel Fremont and Major Emory, p. 275. Dublin, 1849.) Lieutenant Parke, enroute through southern California in 1854, was impressed by the irrigation facilities found at the settlement of Los Angeles. "Most of the fine graperies," he observed, "extend along the river-side. In the vineyard of Don Luis Vignes the vines are watered by open drains from the river, which run down one side of an allotment with side sluices for allowing small streams to flow in between the rows and irrigate the ground. . . . Many of these vineyards are very extensive and are said to contain from 25,000 to 30,000 and even 40,000 vines, the stock of which was brought by the padres from Spain and France." (Parke, Lieut. John G., Reports of explorations and surveys to ascertain a railroad route from the Mississippi River to the Pacific Ocean [1853–1856]. Ex. Document 91, Vol. VII, pp. 80–81. House of Representatives, Washington, D. C., 1857.)

Grapes and wine were much in demand, and constituted the cash crop of pueblo farmers. For the year ending June 1850, Los Angeles County produced 57,355 gallons of wine, valued at $6,550 according to the Federal Census. (Seventh Census of the United States, 1850. Washington, D. C. 1853.) During the period of the gold rush, grapes from the southern districts found a ready market in San Francisco and the mining towns adjacent to Sacramento. Even as late as 1859, grapes were shipped to northern markets. The report of coastwise shipments of domestic produce from the port of San Pedro for the year ending October 31, 1859 lists grapes and wine as the exports of greatest value. During that period, 22,974 boxes of grapes, valued at $67,484, and 183,500 gallons of wine with a value of $138,625, were exported, the bulk of the shipment going to San Francisco. (Los Angeles Star. September 24, 1859.)

Beyond the limits of Ord's Los Angeles, intensive cultivation was restricted. Powell's sketch of the city (Figure 4), made only seven months after Ord's survey, depicts the cultivated land west of the river, but indicates no cultivation east of the gulch. (The Santa Fe Trail to California, 1849–1852. The Journal and Drawings of H. M. T. Powell. Edited by D. S. Watson. The Book Club of California, Grabhorn Press, San Francisco, 1931.) However, with the extension of the zanja system,

grape plantings became numerous on the east terrace. In this district during 1859–1860, H. D. Barrows watered a vineyard of 29,000 vines. (Barrows, H. D., Water for domestic purposes versus water for irrigation. Publications of the Historical Society of Southern California, Vol. VIII, pp. 208–209.) But the vast area out of reach of the fructifying waters of the river was devoted exclusively to grazing.

On the Ord map the confused mosaic of holdings and the haphazard arrangement of roads in the district of the original planting fields reflect the irregular methods of land acquisition during the thirties and forties. The roads—mere lanes—followed farm boundaries. An exception is noted in the main road which bisects the cultivated area between Calle Principal and the river, the present Alameda Street. The original Spanish trail which skirted the base of the hills—Portola's path in 1769—persists on Ord's map. And only in the newly plotted section of the city of 1849 does a conventional net of streets appear.

There is no historical evidence that the hills immediately west of the settlement played a military rôle during the early days of the pueblo. Not until the time of the American conquest was the elevation, Fort Hill, fortified. Here, after the first conquest of the territory in 1846, Captain Gillespie of the United States Army stood siege during an uprising of the Californians. Following

FIGURE 5.—The civic center of modern Los Angeles embraces the site of the original settlement, notwithstanding a tremendous areal expansion of the city during the present century. The course of Los Angeles River roughly traces the upper margin of the photograph; a portion of the hills that confined the early pueblo on the west are seen in the lower left-hand corner. (Spence Air Photos, Los Angeles.)

the recapture of Los Angeles by Commodore Stockton and General Kearny the next year, a redoubt, Fort Moore, was constructed on Fort Hill, but was abandoned shortly thereafter. (Guinn, James M., Publications of the Historical Society of Southern California. Vol. IV, pp. 141–147.)

It is interesting to follow up the part played by the terrace, river, and hills of the original site in the later decades of Los Angeles' development. The hills to this day present a barrier. They barred expansion for many years, setting a limit to the occupancy of lands on the west. With the eventual spread of the city in that direction, several tunnels were cut to connect the newer residential and business districts on the west with the old center, but this improvement came late. The first tunnel was completed as recently as 1901.

In the eighties, following construction of streets, the hills overlooking the plain and river became a high-class residential district for a short time. Then retrogression set in. Today, the flamboyant architecture of these run-down houses dates the period of their heyday.

The hills, however, may come into a more positive utilization as befits their prominence. According to W. H. Schuchardt of the Los Angeles City Planning Commission, the hills adjacent to the terrace "supply excellent sites for superior types of multiple dwellings," close to the new Civic Center. They make possible "an unusual architectural crescendo leading to a grand climax a hundred feet above the lower land," and thus offer opportunities in the projected Civic Center for "a truly great modern acropolis." (Schuchardt, W. H., *The Civic Center*, in "Los Angeles, preface to a master plan." Publication XIX, p. 240, The Pacific Southwest Academy. Los Angeles, 1941.)

The rural aspect of the city persisted until the late seventies. *Urbs in horto*, a city within a garden, aptly described Los Angeles at that time. Business and social life centered round the plaza. North of the plaza lay Sonoratown, "as Mexican as though transported bodily from Old Mexico." (Workman, Boyle. The City That Grew. P. 114. Los Angeles, 1935.)

The event that ushered in the transformation from rural town to metropolis was the completion of transcontinental railroads to Los Angeles. The Southern Pacific Railroad reached Southern California in 1876, and the Santa Fe nine years later. A rate war ensued which was a contributing factor in drawing thousands of new residents to California. Population grew rapidly, business increased and the city began an areal expansion which has carried its boundaries miles in all directions from the parent core.

Vineyards and orchards on the terrace gave way to factories, wholesale blocks and business houses. Railroads and electric transportation lines criss-crossed the area recently under cultivation. The zanjas that had served the early farmlands disappeared. Bridges spanned the river. And the river itself, *raison d'être* of the original settlement, continued to serve the enlarged city. Even today this small and almost invisible stream contributes an appreciable per cent of the total water supply. Easily recovered as it emerges from the San Fernando Valley, through infiltration galleries it is diverted into municipal reservoirs.

The location of the Civic Center of modern Los Angeles in close proximity to the old plaza ties the present to the past in utilizing the parent center, heart of the settlement from the days of the city's founding.

THE PORTALES REGION: A PUMP IRRIGATION DISTRICT IN THE LLANO ESTACADO

Alfred W. Booth

THE most pressing problem facing the agriculturalist of the Llano Estacado is the problem of securing and insuring an adequate water supply, a problem which has become especially serious in the last decade because of numerous severe droughts. Since the absence of large streams with a regular flow of water has deprived the area of the usual source of irrigation water, the farmers of the Llano Estacado have had to turn to ground water as a means of supplementing their water supply. As yet, many questions with reference to ground water irrigation have not been answered satisfactorily, although from experiments to date, it now seems that pump irrigation may revolutionize the agriculture of the Southern High Plains.

The Portales region in Roosevelt County, New Mexico (Figure 1), one of the areas in the Llano Estacado where pump irrigation is carried on, has been serving as an excellent testing ground in answering the questions facing those interested in utilizing ground water. This statement is made for several reasons. Perhaps most important to the status of the Portales region as an experimental area are two non-physical facts. The first is the length of time in which pump irrigation has been practiced, for its period of 35 years is far longer than that of any other irrigation district. The second is the variety of agricultural interests of its farmers (Tables I and II), which has enabled them to test the practicability of pump irrigation for several types of farming as well as for a variety of crops. Also important to its status as a "control" area is the fact that its physical environment, especially with regard to the conditions under which ground water is found, is also similiar to that of other areas in the Staked Plains where ground water irrigation is feasible.

TABLE I

SELECTED IRRIGATED CROPS, ACREAGE, PRODUCTION, AND VALUE, ROOSEVELT COUNTY, NEW MEXICO, 1929

Crop	*Acres*	*Production*	*Value (dollars)*
Wheat	175	2,200 bushels	2,288
Sorghum for grain	233	3,810 "	2,286
Sorghum for fodder	380	377 tons	3,430
Sorghum for syrup	65	11,300 gallons	11,300
Corn	202	6,010 bushels	4,207
Alfalfa	434	1,014 tons	17,068
Cotton, lint	675	350 bales	30,375
Cottonseed		133 tons	3,658
Peanuts	353	13,867 bushels	19,414
Field Beans	59	1,716 "	4,976
Sweet Potatoes	1,172	202,002 "	323,203
Total Vegetables	641		70,027
Tomatoes	493		53,457
Peppers	13		2,380
Cantaloupe	23		2,277

U. S. Census Bureau

TABLE II

TYPES OF FARMS ON IRRIGATED LAND, ROOSEVELT COUNTY, NEW MEXICO, 1929

Type	*Number*
General	25
Cash—grain	3
Cotton	10
Crop Specialty	109
Truck	20
Dairy	5
Animal Specialty	6
Stock Ranch	2
Poultry	2
Unclassified	4

U. S. Census Bureau

An examination of the climate of the Portales region as representative of

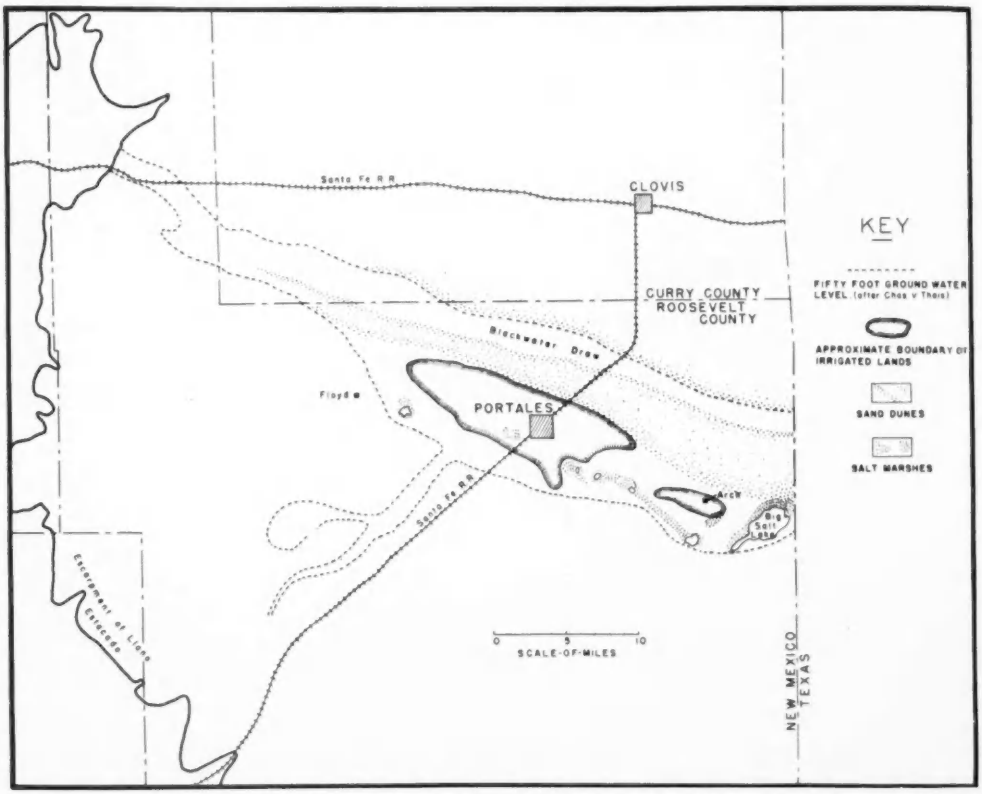

FIGURE 1.—The Portales Region. In the vicinity of Portales the Pleistocene valley extends some three or four miles beyond the fifty-foot ground-water level.

the Llano Estacado reveals three important facts: (1) that the average precipitation is inadequate for ordinary agriculture; (2) that rainfall is unreliable and erratic, and (3) that temperature conditions permit the growth and maturing of a wide variety of middle-latitude and even subtropical crops. The average annual precipitation at Portales is 17.62 inches, with over 80 per cent coming during the growing season, mainly as convectional rainfall. However, the effectiveness of this precipitation is reduced by its unreliability and a high evaporation rate. Below average rainfall has been recorded in over one-half the years that reports have been kept at Portales. If we may judge from the records of nearby stations, the evaporation rate during the growing season is in excess of 50 inches. At Portales the monthly mean for January is 37 degrees F. and for July, 76.4 degrees F., with the growing season extending over more than 200 days. The high percentage of possible sunshine during the growing season (over 80 per cent) is also agriculturally significant.

Most areas of ground water utilization in the Llano Estacado depend upon the collection of rain water in porous sediments perched upon the "cap rock" or other impervious beds for their ground water supply. The Portales region is no exception, for its ground water supplies are derived from the sands, silts, and gravels occupying the abandoned valley of a stream which crossed the Llano Estacado during

Pleistocene times. Fluviatile and aeolian materials filled up the original valley so completely that now only low gradual slopes indicate its presence within the plain. The entire water catchment basin, including the ancient valley and some land surrounding it, covers an area totalling 850 square miles. Especially important to the collection of water are the two series of parallel sand dunes which run the length of the valley and which rise from 50 to 100 feet above its general level. Because of their height and sandy character, no effort is made to farm them (Figure 2). They also serve to divide the valley into two longitudinal basins. The northernmost, Blackwater Draw, is not as yet utilized agriculturally. The southernmost and largest, usually referred to locally as the Portales Valley, is the scene of the pump irrigation agriculture (Figure 1).

FIGURE 2.—Dune area north of Portales. These bunch-grass covered dunes perform an important service by acting as excellent water catchment areas.

The depth of the water table within the Portales Valley varies considerably. It reaches the surface at several places toward the eastern end of the valley where there are a number of salt lakes and marshes. The water table drops more than 50 feet below the surface toward the southern edge and western end of the valley. The irrigated area is located between these extremes, where the water table is not so close to the surface that soils are alkaline or poorly drained, or where it is too deep to dig wells for farmstead use (Figure 1).

Most wells used for irrigation are drilled to a depth of 100 feet into a gravel pan which makes an excellent catchment zone. This gravel pan is just above the red clay upon which the valley fill is perched. Shallower wells dug into the upper zone of ground water saturation are used mainly for supplying water for stock and household needs (Figure 3). Surveys have shown that at least 68 square miles within the valley can be irrigated under present practices without reducing the ground water table too seriously.

The ground water of the Portales region was first tapped just after the Civil War when Portales was quite literally the "gateway" to central New Mexico. The village of Portales was then a watering and resting place for immigrants to the Southwest. Later all the surrounding land became part of the cattle country of our West. Thus the cattlemen became the first occupational group to settle this area. At the turn of the century another group was added, the wheat farmers, who entered the area from the Northwest via Kansas, Oklahoma, and the Texas Panhandle.

A short time later a third cultural element was introduced, cotton farmers, who entered from the Southeast as an overflow from those who were extending cotton production into the subhumid grasslands of Texas. It was probably this latter group, interested in cotton, corn, and peanuts, which first irrigated small patches of land, pumping the water with windmills. In 1910 organized and large-scale irrigation was first attempted when a central power plant was installed for the purpose of providing electricity as power for pumps. Lack of coöperation, ignorance of water needs for various crops, and dissension between the farmers and the power company doomed the venture to failure and it was broken up during the World War when the electrical equipment was sold. The 1919 census has no record of any irrigation project in the Portales region.

FIGURE 3.—In the Portales region, water for use about the farmstead is obtained from shallow wells. Wind is the usual source of power. The well shown above is 35 feet deep.

However, in spite of this failure, the farmers of the district realized the potentialities of ground water and by 1925 pumping began again. By 1929, 166 pumping plants were in operation and 4,823 acres were irrigated. The success of this second attempt may be ascribed to the great use made of gasoline pumps (Figure 4), which do not require coöperative effort to buy or maintain, and to the introduction of a variety of sweet potato which furnished a good cash crop for the area (Figure 5). The success of the sweet potato encouraged the production of other vegetables, and soon some of the farmers became fulltime truck farmers. Since about 1934 dairying has been added to the list of types of farming common to the region.

At present there are over 300 wells within the valley, supplying the water to irrigate over 10,000 acres. The oasis character of the Portales region as a result of this irrigation is readily observable. It is bounded rather sharply in most seasons of the year by a line of contrasting colors, with the grey-green of native pastures and the yellowish-brown of wheat fields of the unwatered areas merging quickly into the fresher greens of the irrigated land. Within this color boundary, rows of trees, frequent farmhouses, small fields (Figure 5), section and half-section line roads, and small pump houses (Figure 9) are unusual elements in the landscape of the Llano Estacado.

All of the various types of farming which were introduced into the region are still found there. As a result of these varied interests, the cropping picture of the valley is a complicated one. This diversity is well expressed by the United States Bureau of Census in the legend which accompanies their map showing type-of-farming areas of the United States. They describe the

region thus: "Roosevelt County—Pump Irrigation—Broomcorn, Sweet potatoes, some Truck, Cotton, Cash-grain"; and "High Plains—Cash-grain, Sweet potatoes, Broomcorn, Livestock, Cotton, Dairy." This diversity suggests that the classification of farms into type categories is a difficult one. However, for the purposes of discussion, it is possible to recognize at least five types of agricultural economy or cropping systems within the region. These are: (1) truck farming economy; (2) economy based on the production of what might be termed the semi-intensively produced crops; (3) cash-grain economy or extensive farming system; (4) dairy farm economy, and (5) ranching economy.

FIGURE 4.—A gasoline-powered irrigation well. This well flows at the rate of 1,200 gallons per minute. It is 117 feet deep, slightly deeper than the average for the Portales region. Notice the sandy character of the soil.

The truck farming economy of the district is based upon production of the sweet potato. This crop is grown for sale in the Southern California market which is made accessible by the main line of the Santa Fe Railroad which runs through nearby Clovis. About 200,000 bushels are raised annually. Like most crops of the area, the potato is planted as soon after the last frost as possible. During the course of the year, water is applied to the fields six or seven times. The harvest period is between October 25 and November 15, just before the first frost. The potatoes are stored in a battery of 36 warehouses (Figure 6) located along the railroad line and are shipped when needed.

Originally the potatoes were grown on the same tracts of land for several successive years, but the ravages of a *nematode* led to crop rotation and also forced producers to use new, uninfected land near the edges of the irrigated district. As a result of this enforced rotation and of the increase in land used for intensive production, other crops were introduced and have made the sweet potato relatively less important to the truck farming economy of the district. There has been no increase in potato production in the last ten years. Chief among the new crops to be introduced was the tomato. Others are carrots, beans, watermelon, onions, and sweet peppers. All of these crops require from six to ten waterings during the growing period.

The three chief problems which face the truck gardeners of the district, exclusive of the water problem, are the same which would face truck gardeners in any irrigation district of the High Plains. These are the problems: (1) labor supply; (2) disposal of fresh produce; and (3) disposal of surplus produce. In the Portales region the heavy labor requirements of the harvest period are met by migratory laborers, probably 500 of whom enter the area during the peak period. These workers usually live in shacks and tents erected on the outskirts of Portales (Figure 7). Presumably this same labor supply following the harvests would be available elsewhere.

Since the Portales region is so far away from urban markets, the problem of disposal of fresh produce is serious.

As mentioned previously, the sweet potatoes are sent to Southern California. The other products are sent fresh to Dallas, Fort Worth, Kansas City, Oklahoma City, and other large cities to the east. At present, vegetables are shipped to these markets in burlap bags with only such grading as provided by individual producers. Because of this system, Portales products are unidentifiable and do not receive premium prices in the market. A coöperative marketing scheme like that used by vegetable growers in California and elsewhere is being advocated in order to standardize and advertise the products of the district. Such a scheme would undoubtedly insure a regular market and good prices for the area, factors particularly important in view of the need for cash to pay for water pumping and other costs of production.

Because of the limited market available, and because produce of inferior grade or produce which has matured too late to reach the market at the peak of demand and prices will always be on hand, the area is also faced with the problem of disposal of surpluses. Thus far, the excess production of tomatoes and beans in the Portales area has been taken care of in the local cannery (Figure 8). A starch-sizing plant for utilizing surplus potatoes is being planned.

FIGURE 5.—Two views within the Portales region. To the left is a sweet potato field, to the right a peanut field. Notice the flatness of the valley floor and the rather typical hedgerows along the field boundaries.

FIGURE 6.—One of the 36 sweet potato warehouses in Portales.

It would thus appear that in order to make truck gardening profitable in other pump-irrigation areas, certain lessons can be taken from the Portales region. Rotation and diversification of crops, the organization of marketing coöperatives, and the construction of processing plants to dispose of surplus produce seem to be the three most important.

The second common system found in the region is the system which is based upon the production of semi-intensively produced crops, such as cotton, peanuts, broomcorn, and alfalfa. The term semi-intensively is here meant to convey the idea that these crops do not usually require so much water or care as truck crops, but do require more than crops like wheat or grain sorghums. Sweet potatoes are also produced under this system. Outside of the sweet potato, perhaps the crop which is proving most successful is the peanut, for the sandy, loam soils of the valley are well adapted to its requirements, and with the establishment of a number of roasting plants in Portales, a good market is always at hand. Alfalfa, too, does well in the area. Most of it is used locally by dairy farmers and stock raisers. Cotton grows well, but recent low prices have reduced production considerably. However, a number of areas in the Texas Panhandle where cotton is pump-irri-

gated report such a venture entirely profitable. Several cotton gins are located near and in Portales.

The two common crops in the valley which require watering only in exceptionally dry years or during exceptionally dry periods are winter wheat and grain sorghum. That the Portales region is as yet in the experimental stage in the development of irrigation is strongly brought out by the fact that broad unirrigated wheat fields surrounded by small intensively worked and watered fields of truck crops are still a common sight within it. The farmers of the region have satisfied themselves that the watering of grain sorghums is a paying proposition, but there is some debate as to the profitableness of irrigating wheat. Pump-irrigation experiments in Kansas and the Texas Panhandle seem to bear out these conclusions. Two small flour mills have been established in Portales to serve the local market with the thought that this step might make wheat irrigation entirely feasible.

The fact that forage crops like grain sorghum, alfalfa, and corn are available has led to the growth of dairying. A few years ago the Kraft Company creamery established in Portales created an excellent market for dairy products. A few ranchers are finding that irrigating forage crops for feeding beef cattle is a successful venture.

The mechanics of irrigation are fairly simple. As mentioned before, irrigation wells are usually drilled to a depth of 100 feet. The water is brought up by gasoline pumps (Figure 4), although in the last few years natural gas and even electricity have been used as power sources. All are proving satisfactory. A good pump will bring up water at a rate of 1200 gallons per minute, sufficient to water three acres to a depth of five inches in a day. In the valley this is ordinarily considered a "watering." Because the valley floor is very flat, the water is conducted to the fields in raised ditches. These ditches are constructed simply by piling up sand ridges and running channels throughout their length. When a field is to be watered, the ditch is breached and the water runs into the field, spreading over it by running along furrows, following any slope which exists. The method entails a great deal of waste through loss of water by evaporation and especially by seepage and in addition, it sometimes

FIGURE 7.—A migratory worker's shack on the edge of Portales, a common sight along the main highways during the harvest season.

results in unequal watering of the field. However, it has not yet been determined whether metal conduits or permanent concrete-lined ditches will save enough water to pay for their installation. According to the United States Census Bureau, the cost of irrigation in 1929 was $6.89 per acre. Estimates by farmers of the cost per acre vary considerably, but mostly range between $4.50 and $7.50.

Several conclusions may be reached from the experiences in the Portales region, and these can be substantiated to a certain degree by conclusions reached elsewhere. It has been definitely determined that ground water found under physical conditions as that of Portales is entirely satisfactory as to quality. It has also been determined that under these same physical condi-

FIGURE 8.—The general cannery, Portales, a necessary adjunct to the truck farming of the region.

tions, the amount of water available can be estimated quite accurately. This would seem to indicate that water conservation districts like that set up in the Portales region are entirely feasible. It might also suggest that some scheme of water proration could be established for the water users of each district as a conservation measure. Such a water proration scheme would, however, be subject to all the legal difficulties and complexities associated with oil prorating schemes.

Another conclusion that may be made with a high degree of safety is that under existing economic conditions within the Llano Estacado, it is not profitable to pump for irrigation water from very much below 100 feet. Only under unusual circumstances does it pay to bring up water from underneath the cap rock. An example of profitable deep-driven well irrigation is found in the market gardening area just outside of Amarillo, Texas, where an unusually large urban market is available.

Another factor which must be considered in determining irrigation expenses is the cost of the power used to run pumps. The Llano Estacado is especially fortunate in that it possesses large gas and oil fields. The installation of gas lines and local oil refineries within recent years has made this gas and oil available to most pump-irrigation districts at a low price. It is claimed that natural gas is from a third to a half cheaper than gasoline as a fuel. However, original installation costs reduce this advantage. There is a growing tendency in the Portales region for gas to become the fuel for the larger pumping projects (Figure 9). Electricity is not used a great deal because of high cost, although since an electric motor may be controlled automatically, it has the advantage of reducing the time spent in caring for pumps. Increased rural electrification may, in the future, make electricity a common power source.

The cost of pump-irrigation necessitates a rather high cash return from each acre irrigated, which points toward intensive agriculture in irrigation districts. However, the marketing problems of the area are such that extensive agriculture would seem more normal. The farming systems of these irrigation districts of the Llano Estacado must thus be a compromise between these two broad types of agriculture, or better, must be established so as to fit into the extensive agriculture of the non-irrigated Llano Estacado. It is perhaps because of this compromise and supplemental status of irrigation agriculture in the High Plains that such a variety of crops and farm types exist in the Portales region.

A theoretically efficient pump-irrigation district in the Llano Estacado would thus have a limited acreage in

FIGURE 9.—A pumping station. Natural gas is the fuel. This well is 105 feet deep.

truck crops. These products would, for the most part, be disposed of locally, but some special crops would have a broader outside market, like the sweet potatoes and tomatoes of the Portales region. In addition, the urban center of the district should contain processing plants to dispose of any surpluses. Perhaps a system of coöperative marketing could best handle this situation. This theoretical district would have a larger acreage in crops which would require less care and less water than truck crops. Here again, local processing plants, like the peanut roasters or cotton gins of Portales, would be present to expedite marketing and shipping. These semi-intensively produced crops might, like peanuts or alfalfa, be used to support a local dairying industry or be sold to the livestock ranchers of the surrounding areas. The third, and perhaps largest group of crops, would be those which require only supplemental irrigation, like wheat and grain sorghum, with low water costs but with a fairly regular market at all times. These various kinds of crops could be produced on several types of farms, although the production of all types on one farm might be the ideal situation.

Undoubtedly a few more years will be required to answer all the questions concerning pump irrigation, but when they are answered, many agriculturalists of the Llano Estacado can look forward to a period of agricultural stability such as they have never before experienced.

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Generally speaking, geographers more than historians have been interested in attempting to understand and to present the basic facts underlying the culture and the civilization of the countries of Latin America. Particularly have geographical periodicals taken the lead in this respect by publishing valuable scientific studies of the economic background and international economic relations of our neighbors to the south. Among these periodicals is ECONOMIC GEOGRAPHY which since its inception in March 1925 has been foremost in using maps, charts, graphs, and illustrations to enhance the value of its articles.

Today, when interest in Latin America is so rapidly increasing, it is particularly helpful to refer to the economic and geographical literature in the field of Latin American affairs. This list, therefore, has been compiled as an aid to the student of the subject who may wish a ready reference to important publications supplying a background for a better understanding of the peoples and politics, as well as of the economics, of the other nations in this hemisphere. The items here given are arranged under two logical heads with several subheadings. Only original articles are listed; all notes, book reviews, etc., even though they concern Latin America, have been omitted.

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A. CURTIS WILGUS

BOOK REVIEWS

KELLOGG, CHARLES E. *The Soils That Support Us.* x and 370 pp. The Macmillan Company, 1941.

Soils science has made incredible progress during the last quarter century, advancing so fast that not even geologists and biologists, those scientists most closely concerned with the subject matter of the science, have been able to keep pace with it. Probably the geographers and the agronomists have more nearly kept up with the procession than any other of the related scientists, but even they have not been able to move forward so rapidly as have the men engaged in soils science itself.

Needless to say then, the lay public has lagged still farther behind and except in the most applied phases of the science, not even the farmers have appreciated the wealth of material and its significance that the soils scientists have provided within the last generation. Most of the results of soils research and soils surveys have been buried in government publications to which the public has not had easy or ready access, and a great deal of it has been presented in such technical terms and such scientific style that it has not been comprehensible to the average layman. Such monographic publications as the 1938 Yearbook of the United States Department of Agriculture "Soils and Men"; "Soils of the United States," Part III of the Atlas of American Agriculture; and "Soil Conservation," all contain a great deal of interesting and valuable information for any good American citizen, but all of them are so ponderous and detailed that few persons have the courage to try to master them.

Now, however, Charles E. Kellogg, Chief, division of Soil Survey, Bureau of Plant Industry, United States Department of Agriculture, comes forward with a wholly different kind of volume, modest in size, simple in style and language, thorough in workmanship, deeply interesting in its well selected material, and attractive in format, to offer every up-to-date and enterprising citizen, particularly the farmer and the friends of the land, opportunity to learn all the salient knowledge about soil that the scientists have so industriously and so successfully garnered for more than twenty-five years. From this one volume everyone interested in the development of soils, their distribution and character, their relationships and attributes, and their rôle in agriculture and national economy, can easily lay the foundation for a thorough understanding of soil processes and the relationship of soils to crops, pasture, and forest; to health and welfare; to economic prosperity and defense needs. Though written with the idea in mind of making soils science clear and intelligible to every reader, it retains scientific accuracy, sound interpretation of fact, and adequate inclusion of all relevant and significant material. It is not "written down" to anybody, yet it is

neither complicated nor difficult; in short, it is just the kind of book that the average American likes to keep at hand for information and reference, the kind of book that he can easily read, and just as easily understand.

Henceforth there can be no excuse for the geographer, the geologist, the biologist, or the economist to be ignorant of the vast body of knowledge which the soils scientists have gathered together so effectively in recent years, nor of the important part that soils play in the complex economic structure of the industry of our country. "The Soils That Support Us," is sure to remain a popular and valuable book for many years to come.

W. E. E.

PEATTIE, RODERICK. *Geography in Human Destiny.* 323 pp. George W. Stewart, New York, N. Y., 1940.

Just as Kellogg's "The Soils That Support Us" is sure to popularize soils science, so Roderick Peattie's "Geography in Human Destiny" is sure to go a long way toward popularizing modern geography. While most of the geographers have been arguing among themselves as to the essential concepts, materials, and purposes of their science, Roderick Peattie has accepted the inventory which the centuries and popular opinion have made of the subject. Accepting this time-winnowed popular appraisal as adequate for his purpose, he has given to the public a fascinating explanation of the relationship between man and his activities and attributes on the one hand, and land and its attributes on the other.

There is nothing pedantic or painfully erudite and involved about his book. Peattie writes as entertainingly and easily as he talks and makes friends everywhere he goes, little hampered by tradition, little worried about other folks' opinions; consequently it is hard to find a dull page in his book, and just as hard to find a murky explanation. There are contradictions here and there, a few digressions that are not geographic now and then, but on the whole it is a scholarly, yet withal charming, exposition of the field of geography.

The book can truthfully be said to be a "popular" geography rather than an economic geography or a political geography or a regional geography, or any of the other kinds of geography that the professional geographers have written, chiefly as text or reference books. Most other so-called popular geographies have been written by non-geographers, because geographers could not get out of the rut of professional thinking; but Roderick Peattie is a full-fledged geographer in his own right who would not be confined in any kind of rut in any kind of subject. If he had been a mathematician or an astronomer or a chemist he would have been just as sure to have escaped the pedantic limitations of his field as he has in geography. Though he is neither rebel nor radical, he is independent and resourceful; and it is because of these innate qualities that he has been able to transgress the limitations of the field in which he has been trained, and write popularly though soundly and as a scholar.

"Geography in Human Destiny" is welcome relief from the dull encyclopedic or descriptive things that geographers have been prone to write to date; and though few geographers will agree with all his statements and conclusions, all the impressions that Peattie leaves with his readers, most of them will appreciate and applaud his effort to make geography live and interesting.

W. E. E.

JENNY, HANS. *Factors of Soil Formation.* 281 pages, illustrations and bibliography. McGraw-Hill Book Company, New York, 1941.

In the author's words (p. 17), "It is the purpose of the present book to assemble known correlations between soil properties and soil forming factors, and, as far as is possible, to express them as quantitative relationships or functions." To gain this desirable end Dr. Jenny has drawn upon the works of many investigators and his compilation is a fine example of careful organization and coördination. He has summarized and related the more important works of pedologists and soil scientists. Though he has emphasized the soils of the United States, his illustrations from European lands and tropical regions extend the scope of the book beyond mere domestic interest.

To geographers the book is important, even though presentation of conclusions solely in graphs and equations leaves them without their favorite tool, the map; yet lack of map does not detract from value of the book. Detailed analysis of the function of each factor of soil formation investigated (time, parent material, climate, topography, and organisms), yields a clear conception of the value of each in the ultimate result, though summation of the various factors does not achieve a schematic presentation of the whole.

JOHN W. REITH